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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

October Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, October 3d, 1895.

The October meeting of the Society of Gas Lighting will be held at 3 P.M., Thursday, the 10th inst., in the Arena, No. 39 West 31st street, New York.

FRED. S. BENSON, Secretary.

MEETING OF COUNCIL, AMERICAN ASSOCIATION.

A meeting of the Council of the American Gas Light Association will be held in Parlor 20, of the Continental Hotel, Philadelphia, at 7:30 P.M., Tuesday, October 15th, at which the usual preliminary routine business will be transacted.

[OFFICIAL NOTICE.]

Twenty-third Annual Meeting, American Gas Light Association.

OFFICE OF THE SECRETARY, P. O. Box 1160, PROVIDENCE, R. I., October 1st, 1895.

The 23d annual meeting of the American Gas Light Association will be held in Philadelphia, Pa., on October 16th, 17th and 18th, 1895.

The meeting will be called to order by the President, Walton Clark, of Philadelphia, Pa., at 9:30 o'clock, A.M., on October 16th, in the meeting hall at the headquarters, Continental Hotel, which is located on Chestnut street, corner of 9th.

The Continental is conveniently reached by the principal street car lines, as are the other first-class hotels in its vicinity. As the most satisfactory quarters are always obtained by writing in advance to the hotel people, the following list of hotels is appended, and it is particularly suggested that in writing to them a reply be requested, for which a self-addressed and stamped envelope should be inclosed, as misunderstandings and disappointments may thereby be averted. Remember: "First come, first served."

Hotel.	*Rates.*	*Distance from Headquarters.*	*Location.*
Continental (American plan). Special rates to those attending the Convention....	4th, 5th and 6th floors . $2.25 3d floor... 3.00 2d and 1st. 4.00 Rooms with Baths, extra.	This is the Headquarters.	Cor. of 9th and Chestnut streets.
Girard	.....	Directly opposite.	On Chestnut street.
Bellevue (European plan)...	$2.00 and upwards.	6 blocks.	Broad and Walnut sts.
Stratford (European plan)	$2.00 and upwards.	6 blocks.	Broad and Walnut sts.
Metropole (European plan)..	$1.50 and upwards.	7 blocks.	Broad and Locust sts.
Colonnade (European plan).	$1.50 and upwards.	6 blocks.	15th and Chestnut sts.
" (American plan).	$3.50 and upwards.	"	" "
Bingham (American plan)..	$2.50 and upwards.	3 blocks.	11th and Market sts.

The meeting hall had to be changed, as the original plan for the headquarters and hall could not be carried out, owing to the failure of the large hotels uptown to complete their house alterations in time for the convention. By special arrangements with the Continental it was made possible for the meeting to be held there, with the Ladies' Ordinary as the meeting hall; thus the sessions will be held at the headquarters.

Reduced rates for transportation have been secured, methods for obtaining which are given in detail at the close of this notice.

The Roll Call will be made by means of an improved system of door cards, in charge of one of the Committee of Arrangements. Each member upon entering the hall for the first time will at the door receive a special card upon which he will find his name, address, etc., the card then to be given to the doorkeeper after correcting any errors on it. Members in attendance should attend to this very carefully, as these cards are used directly after the meeting in correcting the annual membership list. Visitors will please hand to the doorkeeper their personal cards.

Blank forms for application for membership will be found among the last pages of several issues of the *Quarterly Proceedings*, and may also be had, with full information, by addressing the Secretary.

Applications for membership must be indorsed by two active members and be received by the Secretary on or before October 5th, as if received later than that they cannot be constitutionally acted upon at this next meeting.

The list of papers to be read at the meeting is as follows:

"The Creation of a Healthy Public Sentiment Toward the Gas Company in the Locality in which it Operates," by Mr. W. H. Rogers, Paterson, N. J.

"Retort House Design and Practice," by Mr. A. E. Forstall, Newark, N. J.

"Notes on the Storage of Oil at Gas Works," by Mr. Frederic Egner, Norfolk, Va.

"The Ventilation of Gas Lighted Rooms," by Mr. Irvin Butterworth, Columbus, O.

"Bench Firing with Soft Coal," by Mr. E. G. Pratt, Des Moines, Ia.

"The Commercial Value of Photometry," by Mr. Alex. C. Humphreys, New York City.

In addition to these there will be, in the latter part of Wednesday afternoon, an illustrated lecture on Acetylene, by Mr. W. W. Goodwin, of Philadelphia, Pa.

Members are expected to send in not only papers on original subjects, but also written discussions or analyses of any or all of the papers written by others, such written discussions to appear in the next issue of the *Quarterly*.

Questions for the Question Box should be sent to the Secretary as early as possible, as each one will be referred to some member, who will lead discussion on it, and so it is very desirable that sufficient time be given for proper investigation of the subjects.

The Committee of Arrangements have about completed their programme, and the Secretary is allowed to say that it is expected to make the general programme as follows: On Wednesday forenoon, business session; Wednesday afternoon, business session, including illustrated lecture by Mr. Goodwin; Wednesday evening, it is expected to hold a ladies' reception, with music, at the headquarters. Thursday forenoon, business session, extending to probably 2 o'clock. Thursday afternoon the members, will, by special invitation, go to the Welsbach factory at Gloucester City, by boat, for an inspection of the plant and a most elaborate display of incandescent illumination in the evening. On the way to the Welsbach factory a short trip will be made up the river, showing Philadelphia's commerce and the famous Cramps' shipyards. A dinner will be served on the grounds of the factory by the United Gas and Welsbach Companies, a special pavilion being erected for the purpose. Friday, the Association will go to Atlantic City by special train, returning same afternoon. Headquarters while there will be at the newest and best hotel, an excellent dinner will be served, and the members will have a good opportunity to visit this famous coast resort. The ladies will be well cared for, as usual. Meet each other Wednesday forenoon, gossip and shop rest of the day; reception in the evening. Thursday, drives and gossip; theater parties in the evening. Friday, trip to Atlantic City.

During the days of the meeting bulletin boards will be posted in the lobby of the headquarters and in the meeting hall. All members are warned to take due notice thereof and govern themselves accordingly, that they may be apprised of any change in or addition to the programme.

Each member is particularly requested to wear his badge of the Association in plain sight during the meeting, thereby affording the officers and committees of the Association, as well as others requiring it, a means of recognition, thereby greatly facilitating the work of the meeting and particularly of the Philadelphia Committee.

Many of the members have allowed their dues to remain yet unpaid, and this is a source of much difficulty and extra work to the Treasurer, who has already sent several statements to each of the delinquent ones, as you must know if you are one of them, unless you have failed to notify him of change of address.

TRANSPORTATION.—*Note Carefully for Your Own Convenience.*—The following Passenger Associations have granted the usual concession in railroad rates, viz.:

The Trunk Line Association, composed of the following railroads: Addison & Pennsylvania; Allegheny Valley; Baltimore & Ohio (Parkersburgh, Bellaire and Wheeling, and east thereof); Baltimore & Potomac; *Bennington & Rutland; Buffalo, Rochester and Pittsburgh; Camden & Atlantic; Central of New Jersey; *Central Vermont; Chautauqua Lake (for business to points in Trunk Line Territory); Chesapeake & Ohio (Charleston, W. Va., and east thereof); Cumberland Valley; Delaware & Hudson Canal Co.; Delaware, Lackawanna & Western; Elmira, Cortland and Northern; Fall Brook Coal Co.; *Fitchburg; Fonda, Johnston & Gloversville; *Grand Trunk; Lehigh Valley; New York Central & Hudson River (Harlem Division excepted); New York, Lake Erie & Western (Salamanca, Dunkirk and Buffalo and east thereof); New York, Ontario and Western; New York, Philadelphia and Norfolk; New York, Susquehanna and Western; Northern Central; Pennsylvania; Philadelphia & Erie; Philadelphia & Reading; Philadelphia, Wilmington & Baltimore; Rome, Watertown & Ogdensburg; Western New York & Pennsylvania; West Jersey; West Shore; Wilmington & Northern.

The Southern Passenger Association, composed of the following Companies: Atlanta & Florida; Atlanta & West Point, and Western Railway of Alabama (lines between Atlanta and Montgomery); Atlantic Coast Line; Central R.R. & Banking Co., of Ga.; Columbus Southern; Florida Central & Peninsular; Georgia R. R. (lines between Atlanta and Augusta and between Macon and Camak); Georgia Midland & Gulf; Georgia Southern & Florida; Jacksonville, St. Aug. and Ind. River; Jacksonville, Tampa & Key West; Louisville & Nashville (lines south of Birmingham and east of Mobile); Mobile and Birmingham; Pennsylvania R. R. (line south of Washington); Plant System of Railways; Richmond, Fred. & Potomac; Southern R. R.; Western & Atlantic.

*Only for business originating at, or destined to, stations on the direct lines of these roads between Troy, N. Y., and Montreal, Canada.

The Central Traffic Association, composed of the following railroads: Balt. & Ohio; Balt. & Ohio Southwest; Chicago & Erie; Chicago & Grand Trunk; Chicago & West Michigan; Chicago, Peoria & St. Louis; Cincinnati & Muskingum Valley; Cincinnati, Ham. & Dayton; Cleveland, Akron & Columbus; Cleveland, Cin., Chicago & St. Louis; Cleveland, Lorain & Wheeling; Columbus, Hocking Valley & Toledo; Columbus, Sandusky & Hocking; Detroit, Grand Haven & Milwaukee; Detroit, Lansing & Northern; Dunkirk, Alleg. Valley & Pittsburgh; Elgin, Joliet & Eastern; Evansville & Terre Haute; Flint & Pere Marquette; Grand Rapids & Indiana; Grand Trunk; Lake Shore & Michigan South; Michigan Central; N. Y., Chicago & St. Louis; N. Y., Pa. & Ohio; Norfolk & Western (S. V. Div.); Ohio Central Lines; Pa. Lines West of Pittsburgh; Peoria & Eastern; Pittsburgh & Lake Erie; Pittsburgh & Western; Saginaw Valley & St. Louis; Toledo, Peoria & Western; Vandalia Lines; Wabash; Western N. Y. & Pa.; Wheeling & Lake Erie.

The Western Passenger Association, covering territory west of Chicago and St. Louis, and the New England Passenger Committees, covering territory east of New York State, decline to grant any concession on account of the probable limited attendance from their territories. Members interested are referred to the fourth rule below, under which they can secure special rates from Chicago and St. Louis, and from points east of New York.

The Chicago and Alton Railroad also individually joins in the concession, covering all its stations in Illinois and St. Louis, Mo.

The usual concession in railroad rates has been granted—viz., one-third off on the round trip. That is, members will pay full fare going, obtain a certificate from the ticket agent from whom they purchase their tickets, and upon presentation of this certificate at Philadelphia, duly indorsed by the Secretary, they can obtain the return ticket at one-third the full fare rate.

The following extracts from the regulations of the railroads are cited for the information of the members. The special rates are granted subject to these regulations.

1. The American Gas Light Association is obliged to guarantee to redeem at full fare rates any return tickets procured by persons in attendance at meeting which may afterwards be found in the hands of "scalpers."

2. The reduction is conditional on there being an attendance at the meeting of not less than 100 persons holding certificates.

3. Each person to obtain the excursion rate must purchase a first-class ticket (either limited or unlimited) to the place of meeting, for which he will pay regular fare, and upon request the ticket agent will issue a printed certificate of purchase of the standard form. Agents at all important stations are supplied with certificates.

4. If through tickets cannot be procured at the starting point, purchase short trip ticket to the most convenient point where such through tickets can be obtained, and there purchase through to place of meeting, requesting a certificate from the ticket agent at the point where each purchase is made.

5. Tickets for the return journey will be sold by the ticket agents at the place of meeting at one-third the highest limited fare only to those holding certificates signed by the ticket agent at point where through ticket to place of meeting was purchased, and countersigned by signature written in ink by the Secretary of the Association, certifying that the holder has been in regular attendance at the meeting.

6. No reduction of fare will be made on the return passage if the going ticket is purchased more than three days before the opening date of the meeting, except that when meetings are held at distant points to which the authorized limit is greater than three days, tickets may be purchased before the meeting in accordance with the limits shown in regular tariffs.

7. Certificates are not transferable, and return tickets secured upon certificates are not transferable.

8. The certificate of agent at starting point, duly indorsed by Secretary of Association, must be presented to ticket agent at place of meeting, within three days (Sunday not reckoned except by Southern Passenger Association) after adjournment of meeting. The return ticket will be for the line or lines covered by the going ticket.

9. No refund of fare will be made on account of any person failing to obtain a certificate.

Special.—Be sure to obtain your railroad certificate when buying your ticket for Philadelphia. Apply for ticket and certificate at least 30 minutes before train time. Each person must sign his own certificate at time of purchasing ticket for Philadelphia. Be sure to have the Secretary endorse your certificate at Philadelphia by Thursday noon at latest. Apply for return ticket at least 30 minutes before train time, and have your certificate with you. Any person, ladies included, attending the meeting, is entitled to the reduced rate from the territories named. Members will please hand their certificates to the Secretary, or his Clerk, upon arrival at place of meeting. If there are one hundred persons present, holding certificates, each certificate will then be properly endorsed and handed back to owner, before adjournment.

Extracts from the Constitution.

Sec. 12. Application for Active Membership, or for Associate Membership, or for transfer from Associate to Active Membership, must be received by the Secretary at least ten days prior to the meeting at which the application is acted on.

Sec. 51. No member who owes two years' dues shall be entitled to vote, or to participate in the deliberations of the Association, or to receive a copy of the proceedings.

Sec. 52. Any member whose dues shall remain unpaid for a term of three years, may be dropped from the roll of membership by a vote of the Council.

Respectfully, A. B. SLATER, JR., Secretary.

The Rare Earths Used in the Mantles for Incandescent Lighting.

The London *Journal* furnishes the following translations from the German in the matter of the rare earths used in the mantles for incandescent gas lighting :

The manufacture of mantles according to the Welsbach patents really depends mainly on the admixture of the acid salts of zirconia and thoria with the strongly basic oxides of the cerium group. These latter oxides, of high light-emitting power attract carbonic acid and water from the air, except when in combination with the acid oxides. At the present time, only thorium compounds of the earths found in ytterite appear to be used in the Welsbach mantles. The minerals which for some time have been known to be rich in these earths are thorite, orangite, aeschinite, thorogummite, gadolinite, and ytterite ; and as these have now been found more or less plentifully distributed, they have recently been again used for the production of the earths. The text-book analyses of these minerals are quite unreliable, probably because no satisfactory methods for the quantitative separation of the rare earths have been published.

Commercial thorite of the present time contains from 20 to 40 per cent. of thorium oxide ; but a mineral passing by that name which con tains only 5 to 6 per cent. also comes on the market. It is therefore customary for dealings to be made on the basis of the percentage of thoria it contains. Generally, aeschinite contains up to 16 per cent. of thorium oxide ; gadolinite, 6 per cent.; ytterite, 2 to 5 per cent.; and orthite, only 0.6 to 2.0 per cent. Monazite is found in limited quantities in Norway, where it contains 4.9 per cent. of thoria, but rich stores of it have been discovered in Brazil and other places. The working up of it is, however, difficult, on account of its complex composition and small content of thoria. Brazilian monazite contains about 60 to 70 per cent. of oxides of the cerium group, from 0.5 to 1.5 per cent. of thoria, and a considerable amount of the oxides of the yttrium group of metals. But, as Gray has pointed out, nodules of richer monazite are found.

The Brazilian monazite appears to be almost exclusively used for the Welsbach mantles. The other varities are worked up with difficulty, and the earths are obtained from them at greater cost. Recently, however, a large-grained Australian sand containing 4 to 8 per cent. of thoria has been freely bought, as it is readily worked up. It contains orangite, which is easily extracted with hydrochloric acid. The Brazilian monazite is in amber-colored gravel-like grains, mixed with 10 to 20 per cent. of the original bed in which it was deposited. This consists of speckled gneiss, of which the portions detached by gradual disintegration form the material from which monazite is won. This material contains 0.5 to 2 per cent. of monazite, which is obtained by washing away the lighter particles. The greater portion of this monazite finds its way to the Welsbach factory at Atzgersdorf, near Vienna ; only a small proportion being taken by other firms.

There is a prevalent notion that the Welsbach mantles consist wholly of thoria. In the first place, it may be said that those of the other Welsbach Companies differ not inconsiderably from the Austrian. Apart from the suspension of the mantle from the side, the Vienna productions have a faint, but unmistakable, salmon color when cold, while their radiation is incomparably more brilliant than that, for instance, of the Berlin mantles. In the latter, about half the mantle hangs down over the mouth of the burner, and is not raised to incandescence ; while the support of the Vienna mantles by platinum wire enables them to be adjusted above the burner. It becomes necessary to strengthen the upper part of the mantle where it is supported by the platinum wire ; and therefore only the lower part should be taken for analyses.

Thorium oxide is soluble in carbonates, and is not thrown down by dilution or by addition of ammonia. About 8 to 10 per cent. of a Vienna Welsbach mantle is insoluble in carbonates ; and therefore at least this percentage is not thoria. But a number of oxides of the cerium group of metals are also soluble in like manner ; and these oxides are found in considerable quantity in monazite. Therefore it is improbable that the 90 per cent. that is soluble is thoria ; and terbium especially may be suspected to be present in some quantity. Pure thoria, on account of its absolute resistance to fire, and the absence of any tendency to frit, forms a very stiff mantle ; but terbium oxide and other oxides of the group, when added to it, enhance the brilliancy of the incandescence, correct the tint, and give elasticity and durability to the mantle. According to Dr. Auer von Welsbach, there is no limit to the possible modifications of the tint. Mr. M'Kean states that the best result is obtained with 30 per cent. of the oxides of the erbium-yttrium group. This is the reason why a thorium nitrate containing terbium and yttrium is preferred to the pure substance, and is indeed taken for the latter by the uninitiated.

The thorium earth purified according to Bunsen's method by repeated crystallization and precipitation gives, according to him, neither an absorption nor emission spectrum ; but Thalen ascribes lines of eight definite wave lengths to it—some belonging to the known, and some to the, as yet, unisolated components of the group. A pure thorium earth, fulfilling Bunsen's requirements, can, according to Lecoq de Boisbaudran, only be obtained from the commercial earth by repeated recrystallization of the sulphate, and final precipitation with the oxide of one of the heavy metals. According to this method, the commercial substance has a percentage of only 80 to 85.

Thorium nitrate being now an article of commerce much in demand, a few hints for its valuation may be given here. The pure salt crystallizes colorless and becomes white on drying. A faint yellow color of it or its solution is unimportant if due to traces of organic bodies ; but if iron oxide, uranium oxide, cerium oxide, etc., are the cause, the preparation is unsuitable for use. The pure nitrate should not give a coloration with sulphureted hydrogen, nor with ammonium sulphide when in solution in alkaline carbonates. It is completely soluble in excess of carbonate, and is not thrown out of solution by ammonia or by dilution. On warming, the solution becomes cloudy through separation of the hydroxide, which, however, dissolves again on addition of ammonia. The nitrate crystallizing with 12 molecules of water gives on ignition 37.95 per cent. of thoria. The same salt dried at 100° C. contains 4 molecules of water, and yields on ignition 47.84 per cent. of pure white thoria. More water may be removed from the salt by drying at a higher temperature ; but there is risk of the formation of difficultly soluble basic salts. If the salt with 4 molecules of water gives a residue of more than 47.8 on ignition, it may be concluded that it is contaminated with earths of lower molecular weight. A commercial product yielding 49.2 per cent. of residue on ignition contained 5 per cent. of yttrium and erbium nitrates. This might have been expected, as a mixture of equal quantities of these two salts gave 68 per cent. of residue on ignition. In default of any exact method of separation, the oxides of the yttrium group are estimated indirectly by a molecular weight determination.

The solubility of thorium hydrate in carbonates is not, in itself, a criterion of purity, as has already been pointed out, as the oxides of the yttrium group also have this property. The slightly basic character of thoria renders it easy of recognition qualitatively, though the quantitative analysis is not capable of being carried out very exactly. It is always possible to identify the products from different sources, and therefore it is surprising that, in a dispute, the expert should state that such analyses could not be made. The very dilute solution of thoria which is to be tested is fractionally precipitated with ammonia, so that only about $\frac{1}{10}$ of the oxides present are thrown down ; and the precipitate is kept in contact with the liquid in the cold for about 10 hours with constant agitation. The whole of the oxides of the yttrium group then remain in solution, if they do not exceed 10 per cent. of the mixed oxides. On concentrating the filtrate, the absorption lines of erbium and its allied metals usually may be found, and often also the broad band near *D* indicative of didymium. Erbium and the allied metals show distinctly a broad, faint band between *E* and *b*, four fine, sharp lines nearer *b*, two bands right and left of the solar line $\lambda = 4{,}860$, and two broad, sharp lines right and left of the solar line *C*. Yttrium, ytterbium, scandium and terbium can be recognized in the flame spectrum. After the separation of thorium by Lecoq's method, and the precipitation of cerium by that of Popp, addition of ammonia to the residual solution throws down the whole of the oxides of the yttrium group. Zirconium is distinguished from all the other oxides of the group by the solubility of its hydrofluoride in water.

On analyzing mantles that have been in use for some time, the filtrate from the precipitation with ammonia often has a blue tint, from the presence of copper, which presumably is derived from the burner. In the methods of testing given above, no account is taken of contamination with the better known oxides.

The sudden demand which arose a few years since for thorium nitrate, which hitherto had been merely a laboratory curiosity, seemed likely to be in excess of the supply ; and the price rose to more than $225 per pound last year. It has, however, now fallen to a third of that price, owing to the discovery of more of the raw material and the rivalry of manufacturers. Of the raw materials, thorite, which contains thorium as silicate, and monazite sand in which it exists as phosphate, are the best available minerals. But, as already pointed out, thorite varies greatly in richness ; and some almost valueless ores have reached the market. Monazite sand is rich in cerium and the allied earths; but it may be considered good if it contains 3 to 4 per cent. of thoria. Mr.

R. J. Gray has already described the occurrence and properties of the sand. But the analysis is attended with difficulties to the chemist who has not had special experience of it; and many comparatively valueless lots of ore have been purchased through misleading analyses. In reality, it is safer to rely on the results of the working up of 20 to 50 pounds of the sand as carried out on the manufacturing scale, as some sand which is shown by analysis to be tolerably rich in thorium cannot be worked up profitably. The methods adopted by the manufacturers are, for the most part, kept secret, but are based on the solubility of thorium oxalate in boiling solution of ammonium oxalate, in which the oxalates of the cerium group of metals are insoluble. The oxalate is used as an intermediate product in the production of the nitrate, and is now made in America and exported to Europe for the manufacture of the nitrate. The oxalate is converted into the nitrate by forming the sulphate, and throwing down the hydrate, which is readily soluble in nitric acid.

The thorium preparations of commerce vary considerably as far as their content of thoria is concerned, owing to variations in the amount of water they contain. The anhydrous nitrate contains 55 per cent. of thorium oxide; but the evaporation of a solution of the nitrate cannot be effected without partial decomposition of the salt to oxide before all the water of crystallization is removed. The commercial nitrate contains 47 to 49 per cent. of thoria, which is estimated by igniting the nitrate in a platinum crucible. It is necessary that thorium nitrate for incandescent mantles should be free from iron and alkali; the former affecting the quality of the light, and the latter the durability of the mantle. A mantle made from pure thorium nitrate gives a clear, bluish, but feeble light; and other oxides must be mixed with it to give a high emitting power. The broken and discarded mantles have a certain value, on account of their content of thorium, and actually some are being again worked up. The future of the thorium market is obscure; and prices may again reach their former maximum when the demand increases during the winter months. With the rise of new companies, the consumption of thoria will increase, and though it seems doubtful if impregnating the filaments of electric glow lamps with this oxide will ever be successful, there is a prospect of a greatly increased demand setting in shortly.

How to Overhaul a Gas Engine.

By Mr. J. W. Seers.

By overhauling an engine is meant thoroughly cleaning and repairing such parts as may be found necessary. The cylinder should be cleaned first; this should be done regularly every six months. To do this, the piston, air and exhaust valves, and slide must be taken out. Fig. 1 shows the interior of the cylinder with piston. To take out the piston, uncouple the crank end of connecting rod by taking off the oil cup—this is only bolted on—then take off the nuts from the coupling bolts, draw the top brass off, and draw the bolts out. Block up the connecting rod with some pieces of wood so that it will not fall down, and then turn the flywheel towards you so that the crank hangs down. It should be fastened in this position to be out of the way of future operations. The oil cup on the connecting rod serves a twofold purpose: First, to lubricate the crank; second, to prevent the nuts on the coupling bolts becoming loose. The piston can now be drawn out. To take out the air valve, first take off the nut at the back of the cam lever and draw the lever off. Two nuts will be found on the flange; undo these with a spanner, and take care that the valve does not fall down.

To take out the exhaust valve, first take off the cover and screw in the T-piece supplied for the purpose, then take off the spring and pull out the pin from the bow; the valve can now be drawn out by means of the T-piece.

To take out the slide, first take the chimney off, then loosen the connecting nut on the gas pipe, knock the pins out of the lugs, and draw the arm off. Now loosen the clip nuts and the milled nuts; these will come off together. The jacket and slide can then be taken off. A plate will be found on the cylinder to face the slide; take out the four screws that will be found in it and lever it off with a screwdriver. There is now easy access to all passages to the cylinder.

All dirt and oil must be scraped from the back of the cylinder with the rods that are usually provided. These are very similar to clinker bars in shape. All passages must be chipped clean. The cylinder must now be wiped thoroughly clean and free from dirt. If the engine has been standing for any time, water will most likely be found in the well in the combustion chamber; this must be mopped out dry. The liner must be well oiled before putting the piston back. Take care that the square ignition hole and the small hole above it are clean. There is a small vertical hole that cannot be seen excepting from one position, that is by looking up air valve chamber. It is of the utmost importance that this hole should be kept clean and free from all dirt. These holes should be cleaned every time the slide is cleaned.

The piston should now be cleaned. The junk ring must be taken off first; a bolt passes right through the junk ring to the cross-stay in the trunk fastened by lock nuts; take these nuts off and the junk ring may be drawn off. There are usually five rings on the piston, separated by distance rings; take them all off and thoroughly clean and oil. A

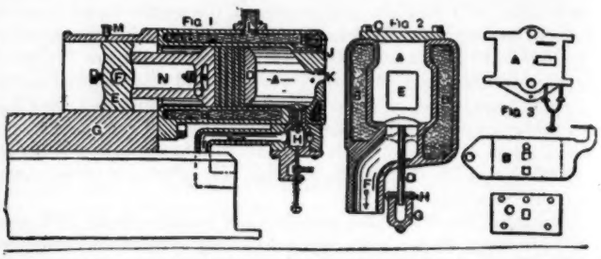

Fig. 1.—Cylinder and Piston in Section. **Fig. 2.**—Exhaust Valve in Section. **Fig. 3.**—Three Faces of the Slide Valve.

small pin goes right through the distance rings. Great care must be taken with the rings, as they are very slight. The trunk must be thoroughly cleaned and oiled, and then all the parts put together. The packing rings should have a very slight play. Before putting the piston back it is well to examine the crosshead brasses; if they are at all shaky it will be found necessary to take the connecting rod off. First undo the screw that holds the pin steady, then knock the pin out from the end; the connecting rod will now come off. A set screw with a check nut will be seen on the end of the connecting rod; undo these and the brasses will come out. Fit the brasses to the pin very nicely and put all together; be careful that the set screw fits into the hole in the pin. The piston may now be put into the cylinder. Before putting it in, turn it right over so that the gaps in the rings come at the top; before pushing it home see that the steady pins fit into the gaps in the rings. The piston should be turned over when about half way in cylinder. Now couple the crank end of the connecting rod. A couple of tin washers should be kept handy, because sometimes when the crank brasses are taken up the nuts will only turn half way round and oil cup cannot be put on.

The air valve should now be taken in hand. To take this to pieces, first take off the collar and spring, then knock out the pin in the lug, and draw the valve out. Thoroughly clean the parts and grind the faces of the valve. Give the valve spindle a few rubs with fine emery cloth and oil and fit all together. Put it back into the chamber and put on the lever.

Next proceed with the exhaust. Thoroughly clean all the parts, grind the faces, and fit altogether.

When grinding in valves, get a little of the finest emery powder and mix with machine oil to the consistency of treacle; smear a little round the face of the valve and grind the two faces together until a bright ring can be seen on both faces, then wipe thoroughly clean.

Next proceed with the slide. It is usual to change the slide when the cylinder is cleaned. If putting in a fresh slide, the pilot light must be changed. To do this, undo the screw and the nut, then unscrew the connecting piece; thoroughly clean the parts, and fit to the fresh jacket. Clean out all the holes in the fresh slide, oil the faces, and put the parts into the respective places, then put on the clips, springs, washers and milled nuts; tighten up the milled nuts as tight as possible, and then tighten the clip nuts and slack out the milled nuts a couple of turns. This is necessary for safety. Connect the gas joint and put the chimney on. Always put the arm on before tightening the milled nuts. The gas valve should be examined, and, if necessary, ground in. The engine is now ready for running.

Now light up the pilot light, and while the slide is getting warm oil all the running parts. Do not forget the cup on the cylinder. Turn on the gas at the meter and open the bag cock. At the side of starting valve a small air cock will be seen; turn it on and apply a light; a blue roaring flame will appear while the air is running out, but as soon as pure gas flows the flame will appear a silent white; then turn the cock off. Turn the bag cock half off. See that the bowl of exhaust lever is on the half-compression (double) cam. Lift the governor catch,

and open the starting valve so that the pointer is a little over the notch on the index plate. Now give the flywheel a few turns until the first explosion takes place (about three turns should be enough), and stand clear; turn the bag cock full on and put the exhaust bowl on the full compression and put the pin in. The engine should now be running all right and without shock. The slide lights must be regulated while the engine is running. If the light keeps blowing out it shows that the taps are not regulated to the supply of gas. This can only be done by experiment on each individual engine; there is no rule that answers for all. There is sure to be an escape of gas by the piston rings, but this will cease in a few days. To stop the engine, first shut off the bag; second, meter; third, starting valve; fourth, the light. When the engine is nearly at a standstill put the exhaust bowl on the double cam; this prevents the engine running backward. Never shut the meter off first.

If the engine will not start, examine all the gas connections and see that the valves seat properly; if these are all right the fault must lie in the slide. If care has been taken in the cleaning, etc., as directed, it must be a very obstinate case, indeed, if it will not start. If the exhaust pipe runs outside the building, and runs into an exhaust box, water will accumulate in it, and must be drawn off two or three times a day.

If the water in the cylinder jacket gets very much hotter than that at the top of the tank, the circulation is obstructed and must be seen to. The pipe leading from the cylinder to the top of the tank must slope upward throughout its entire length, and have as few bends as possible; if this is adhered to there will be no places for air to lodge. A useful tool to promote circulation in the pipes is a suction cup similar to those used by plumbers.

The engine should not run more than 40 hours without cleaning, and should be oiled regularly; about every two hours is usual.

In Fig. 1 *a* is the combustion chamber; *b*, water chamber; c, piston trunk; *d*, junk ring; *e*, crosshead; *f*, pin; *g*, engine frame; *h*, air valve; *i*, air pipe; *j*, gas admission hole; *k*, igniting hole; *l*, upcast water pipe; *m*, oil hole; *n*, junk ring lock nuts. In Fig 2 *a* is the chamber; *b*, water chamber; *c*, cover; *d*, valve spindle; *e*, passage from cylinder; *f*, exhaust pipe; *g*, bow; *h*, pin. In Fig. 3 *a* is the jacket; *b*, slide; *c*, cylinder plate.

Approximate Analysis of the Use of Coal in an Edison Electric Station of the Type Standard, about 1890.[1]

[Read by Mr. R. S. Hale, before the Boston Society of Civil Engineers.]

The system of electric supply from which the following results are derived is the Standard Edison system of a 3-wire underground network for low tension, direct current supplied by underground feeders from three stations, located in Boston, one on Head place, near the corner of Boylston and Tremont streets, one on Hawkins street near Bowdoin square, and one on Atlantic avenue, foot of Pearl street.

These stations pump electricity into the electric mains exactly as pumping stations or gas works might supply water or gas, only since

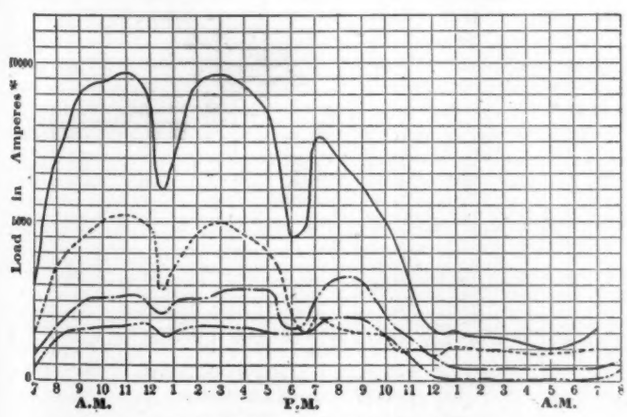

Fig. 1.—Load Diagram, August 21. Weather Fair.
* At a pressure of 110 volts at feeder ends.

the incandescent lamps must be supplied at almost absolutely constant pressure an electric network requires more feeding points than a network of water mains or gas mains.

The stations are as follows: The first station on Head place has 18 units, each consisting of an Armington & Sims non-condensing engine, 15x15½ inches, belted directly to two Edison No. 20 B. P. dynamo. Each dynamo is rated at 400 amperes and 125 volts or 50 K.W., the engines at 135-horse power. The engines are supplied with steam at 95 pounds pressure from six return tubular boilers of 1,800 square feet of heating surface each, and five Babcock & Wilcox boilers of 3,220 square feet of heating surface each. The second station on Hawkins street has

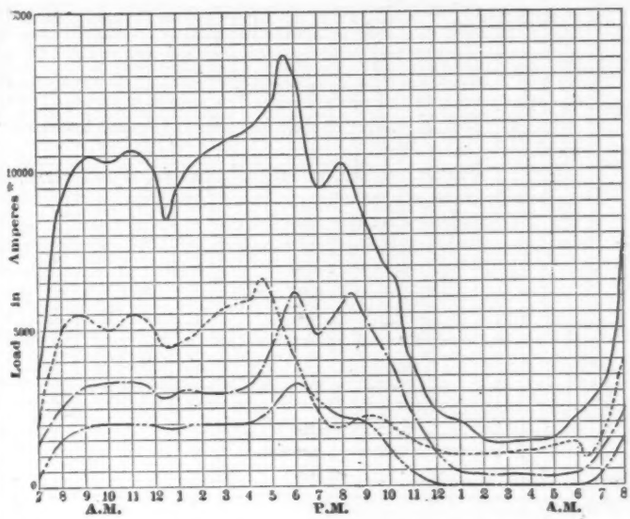

Fig. 2.—Load Diagram, October 1. Weather Cloudy.
* At a pressure of 110 volts at feeder ends.

ten exactly similar units supplied with steam at 100 pounds pressure from two Heine boilers of 2,600 square feet heating surface, one Heine of 1,640 and two Babcock & Wilcox boilers of 2,795 square feet heating surface each. At the Atlantic avenue or third station are four triple expansion marine type condensing engines of 650-horse power each, direct connected to two 200 K.W. General Electric, M. P. dynamos. These engines are supplied with steam at 160 pounds from seven Babcock & Wilcox boilers of 3,737 square feet each. There is also a storage battery of 140 Tudor cells of 3,470 ampere hours capacity on each side of the 3-wire system.

The supply of electric current, which may be used for incandescent lamps, arc lamps and motors indifferently, and is supplied at 110 volts, or 220 volts between the outside wires of the 3-wire system, is best shown by our load curves. Here is a curve, Fig. 1, of a summer day beginning 7 A.M. The first part of the curve is the motor load and office lighting which drops off for lunch at noon and again at 5 P.M. The evening load is residence and shop lighting. In the spring and fall, represented by the curve in Fig. 2, day and night load merge into each other, and in the winter, Fig. 3, they overlap, giving us this peak.

The dotted curves below the full curve of total output are the curves of the districts normally supplied by the different stations. Now the third station is of higher first cost and also of much less operating cost than the other stations. You can readily see that it would not pay to pay interest on costly apparatus to supply this peak that lasts only a few hours a day a few months in the year, independently of the copper needed to transmit this maximum load to the other parts of the city, but yet at light loads it seemed a pity to have costly engines lying idle while cheap ones were eating up the coal pile. Large feeders or tie lines were therefore put in with the idea of carrying our average load during the great part of the time on the engines of good economy, using the Head place and Hawkins street stations only as reserve and to supply the peak of the winter curve. The result is that with less than 40 per cent. of our investment in high-priced economical machinery, we are able to carry over 90 per cent. of our average load on it. It is the same principle as putting in a good pumping engine for water service and a cheap one for reserve and for fire service, only it is a little harder to work out for electric supply.

Up to May '93, we had no tie lines and ran the engines at each station to supply the normal load of the district. Since May, '93, we have been able to shut down the uneconomical stations a large portion of the time, bringing down their average load and bringing up that of the third station. The effect of the tie lines is shown by these curves, Fig. 4.

1. Reprinted from the *Journal*, Association of Engineering Societies,

which give the load manufactured by the different stations and the total. The first three figures give the curves of distributed load. Unfortunately only the second station is available for the comparisons of the use of coal we are now about to make, since the first station supplies a great deal of steam heat of which no record can be made, while various causes in addition to the change of load have affected the third station. For the second station we have the following data by months: Tons New

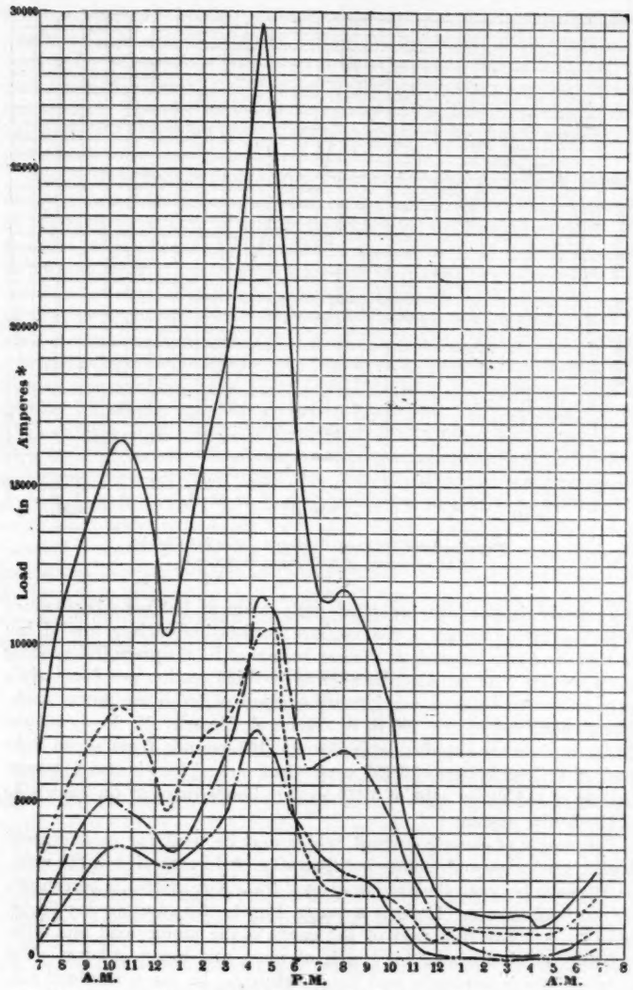

Fig. 3.—Load Diagram, December 12. Weather Cloudy.
* At a pressure of 110 volts at feeder ends.

River coal. Tons wharf screenings. Average K.W. engine hours. These are obtained as follows: At the first of the month coal on hand is measured, amounting to from 50 to 100 tons. All coal brought into the station is weighed on the carts and at the end of the month coal is again measured. Coal weighed + or − difference on hand, is coal used, and is divided between New River and screenings in proper proportion. Half-hourly records are kept of the amperes and volts, which give the K.W. hours, and hourly record is kept of the number of engines running. We then get the derived figures of pounds coal per hour and per K.W. hour and average K.W. per engine. (See table.) These *figures* only show a much worse economy at small average loads, but drawing with average K.W. as abscissæ, two curves, Fig. 5, of pounds coal per hour and pounds coal per K.W. hour we find fairly regular curves, showing that there is a law connecting them. Examining the right hand side of the first curve we find a straight line whose equation is

$Y = a + b\,x$. Where Y = pounds coal burnt per hour x = average K.W. a and b constants which work out to $a = 500$ pounds, $b = 7\frac{1}{2}$ pounds.

These are obtained using only the right hand portion of the straight line curve, which represents times when the station was ready to turn out its full load or nearly so. The left hand portion is when some of the boilers and some of the steam piping is shut down, making in fact a smaller station, which accounts for the droop. In our equation we will first put the load, or $x = 0$. Then $y = 500$ pounds per hour, which is what is necessary to keep the station ready for full load without turning out any load. The other constant is evidently the pounds per K.W. hour of any additional load after paying the 500 pounds per hour to keep the station ready. Seven and a half pounds of this coal per K.W. hour is equivalent to about 50 pounds steam per estimated horse power, or near to 40 pounds per 1-horse power hour, and since the engines are necessarily run a large part of the time either under or overloaded, this does not compare unfavorably with the figures obtained for this class of engines on test runs.

It should be noted that there are enough engines so that the over and underloading of the engines is not markedly different for different average loads on the station as is shown in column of average K.W. per engine in the table.

This constant loss of 500 pounds per hour is composed of boiler losses, which are hot chimney gases, and radiation from boilers, and steam pipe losses, including radiation from steam pipes and steam leaks. The two latter were determined as follows:

All drips were returned by a Gassett trap to a large tank half filled with cold water. The size of the tank being known the increase in depth gave a measure of the condensation. All the engines were shut down, hence the total water used as per meter during the test, or seven hours corrected for height of water in boilers, and minus the water condensed, was a measure of the steam or water leaks. The result was surprising, the leaks amounting to about 500 to 600 pounds water of steam per hour, the condensation to only about half that amount on a warm winter night. Another test on a very cold night gave about 800 pounds leak per hour; a condensation in only a part of the piping was

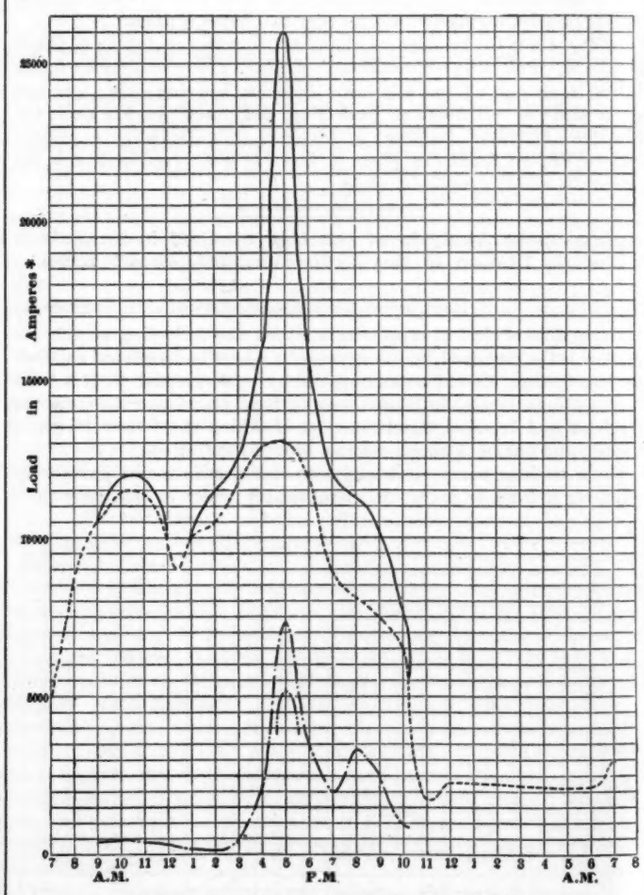

Fig. 4.—Load Diagram, December 13. Weather Fair.
* At a pressure of 110 volts at feeder ends.

about 400 pounds. Still another test, with one-half of the steam piping and all but two boilers shut down, gave radiation 200, leak 600, on a moderately cold night. A test one moderately warm day gave 500 pounds leak per hour. The condensation includes the heating of the second story of the building. The daily figures for water consumption at light loads, after allowing an estimate for use for water closets, etc., and for actual steam in engines themselves, bear out these figures. As

these figures for leak seem very large, I wish to say that at our third station the tests show still larger loss than at the station under discussion, yet at least one member of this Society has twice complimented me on the excellent job of steam piping there. Besides, 600 pounds per hour for even 20 hours is only about 200 cubic feet, and when boilers are left low at end of run and then pumped full to be ready for the next run, such a quantity may easily pass unnoticed. The contraction of water when cooling, and the curious vagaries of the water in the water glass of a banked boiler, would also help the leak to escape detection, without special tests.[1] Six hundred pounds steam leak is about 66 pounds coal per hour. Say 300 pounds steam condensation is about 33 pounds coal per hour. Subtracting these from the total of 500 pounds, leaves, as the boiler losses, about 400 pounds coal per hour for, say 4½ boilers on an average.

Separate tests indicate that it takes about ¾ ton coal per day to keep up the pressure in a boiler of 250 to 300-horse power, without making any steam, which, allowing for somewhat greater loss at full load, checks up the figure of 400 pounds we have just obtained as well as we can expect in any discussion of this sort.

It seems probable that the boiler losses may be chiefly in the chimney and not in direct radiation when we remember how long a boiler will keep up its pressure with the fire drawn, provided the damper is tightly closed, but some boiler trials I have made render me very chary of forming a definite opinion on this subject. We then have for this station of 1,000 K.W. capacity, 1,350 rated indicated horse power, 12,390 square feet boiler heating surface.

66	pounds coal per hour.	.	Steam leaks.
33	" "	.	Radiation from steam pipes.
400	" "	.	Hot gases and radiation from boilers.
Total..500	" "	.	Constant loss independent of load.

Power produced 7½ pounds per K.W. hour in addition to constant loss.

It need hardly be said that these figures should not be considered as an exact analysis, but merely as giving an idea of the relative value of the quantities. Nor are they presented on account of their excellence, though there are many reasons in the nature of our business why we cannot ever get as good results as with the absolutely constant load of a pump, or nearly so of a mill, but I hope they will be of interest as showing some results of actual running. I may add that we are to-day producing power at our new station at a cost per unit less than half of what it formerly cost us in our present sub-stations.

	Tons N.R. Coal.	Tons Dust.	Engine Hours.	Average K.W.	Pounds Coal per Hour.	Pounds Coal per K.W. Hour.	Average K.W. per Eng.
1893,							
January.	421	333	2,432	211.7	2,032	9.57	64.7
Febr'y...	386	292	2,102	198.2	2,080	10.16	63.5
March ..	417	338	2,423	204.7	2,036	9.92	62.8
April....	256	256	1,633	124.9	1,424	11.4	61.2
May.....	147	163	612	46.8	836	17.8	56.8
June...	79	99	114	7.8	496	61.5	50.8
July ...	54	54	7	.3	292	..	50.4
August..	42	58	30	1.2	270	..	30.9
Sept.....	67	83	98	7.2	418	58.0	52.2
October .	92	116	352	17.7	562	31.7	52.9
Nov'r...	87	97	375	25.2	512	21.3	48.4
Dece'r ..	118	134	384	22.5	680	29.9	43.9
1894,							
January.	104	105	596	37.9	748	19.6	47.4
Febr'y ..	98	111	415	30.9	622	20.2	50.0
March ..	92	109	299	20.9	542	25.9	52.1
April....	60	69	184	14 4	258	25.0	56.4
May. ...	7	9	0	0	..	..	.....
Sept.....	6	3	0	0	..	..	.....
October .	29	29	87	7.0	156	22.3	52.9
Nov'r....	86	91	256	21.8	492	22.7	61.4
Dec'r ...	150	155	412	41.1	822	20.0	74.1

By the kindness of the President of one of the Edison Illuminating Companies I am enabled to add as an appendix the following extracts from one of his reports. His station is very similar to the one we have been discussing, except that it is two or three times the size, and has some compound engines:

"Calling your attention to the fact that the operation of this station is for the purpose of earning money, I would particularly call the attention of the Board to the excess of the relative consumption of coal on Sundays over weekdays, as compared with the load. You are all aware that on Sundays the amount of coal burned per horse power hour sold usually more than doubles the amount of coal burned on weekdays; and for this reason our Sunday load is very unprofitable. This discrepancy,

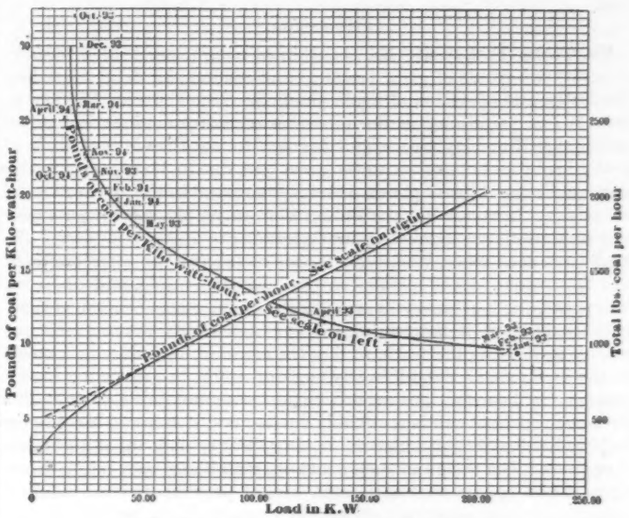

Fig. 5.—Consumption of Coal at Second Station.

however, points out to us the existence of a very large constant waste, and by means of the proper comparison it enables us to determine the amount of this waste:

Average number pounds of coal burned	Sundays,	Dec.,	1893..		70,400
" " " "	"	April,	1894..		62,000
" " " "	week days,	Dec.,	1893.		155,615
" " " "	"	April,	1894.		106,680
" amperes,	Sundays,	December,	1893		1,450.2
" "	"	April,	1894		1,313.6
" "	week days,	December,	1894		5,512.0
" "	"	April,	1894		3,990.6
" voltage,	Sundays,	December,	1893		116.6
" "	"	April,	1894		116.3
" "	week days,	December,	1893		122.9
" "	"	April,	1893		120.0

Solution.

Let W = waste per hour of coal or amount used in appurtenant machines, exclusive of the steam engines. R = true rate per K.W. hour.

For December, 1893, we have:

Sundays, per hour, $2{,}933 - W = 1{,}450.2 \times 116.6\ R.$

Week days, " $6{,}484 - W = 5{,}512.0 \times 122.9\ R.$

$$(6{,}484 - W)\ 169{,}093 = (2{,}933 - W)\ 677{,}424.$$

$$W\ (677{,}424 - 169{,}093) = (2{,}933 \times 677{,}424) - (6{,}484 \times 169{,}093).$$

$W = 1{,}791$ pounds per hour. 19 tons per day.

For April, 1894, we have:

Sundays, $2{,}583 - W = 1{,}313.6 \times 116.3\ R.$

Week days, $4{,}445 - W = 3{,}990.6 \times 120\ R.$

$$(4{,}445 - W)\ 152{,}771.7 = (2{,}583 - W)\ 478{,}872.$$

$$W\ (478{,}872 - 152{,}771.7) = (2{,}583 \times 478{,}872) - (4{,}445 \times 152{,}771.7).$$

$$W\ (326{,}100.3) = 1{,}236{,}926{,}376 - 679{,}070{,}206.5.$$

$$W = \frac{557{,}856{,}169.5}{326{,}100.3} = 17{,}107 \text{ pounds per hour} = 18.3 \text{ tons per day.}$$

The data for the solution of the problem of the waste of this establishment has been gathered for me by Mr. A., as you see, and the numerical values in the equations for April, 1894, have been checked for me by Mr. B., in order to see if the numerical results for December, 1893, are approximately correct.

You will observe that this result of 18.3 tons loss per day very nearly checks the 19 tons loss per day as obtained by myself. The difference is probably due to the difference in temperature in two months.

In what I have to say I will refer more particularly to December, 1893, which problem I have personally solved.

Subtracting 1,791 pounds loss from 2,933 pounds daily consumption for Sundays, I would say that the result shows 5 pounds of coal per electrical horse power. Also, taking up the question of week days, subtracting 1,791 pounds loss from 6,484 pounds daily consumption, the re-

1. See, also, London *Engineering*, April 5, 1895, for the amount of this loss in steamship practice.

sult shows 5.17 pounds of coal per electrical horse power hour produced.

This is the coal used by engines and dynamos engaged in the conversion of steam power into electricity, and it is a very good result for non-condensing engines, such as we have with our very poor quality of coal.

Discussion.

Mr. George H. Barrus—Mr. Hale's interesting paper brings forcibly to notice two points of great practical and commercial value regarding the design and operation of steam plants for electric work. The first of these is one pertaining to the provision of *cheap* engines, instead of *costly* ones, for relay power, and for use during the short periods of heavy load; and the other, to the great loss, due to leakages and careless handling, in steam plants which are engaged in the generation of electricity. In a case like the Edison Company's plant, where the generating stations are divided up into a number of individual plants distinct from each other, where the feeder mains can be interconnected and the various plants operated as one complete whole, and where, as it happens, the machinery in one place is of the most economical type, while in another it is wasteful, the conditions lend themselves most readily to dividing the work, so that the constant load may be carried by the economical though costly engines, while the excessive heavy loads can be taken up and carried by the less economical engines. But the same principle can be profitably carried out, it seems to me, in any large individual station where the driving plant is made up of a number of engines. The design of such a station, embracing, say, half a dozen units, to be consistent throughout, would provide that the engines should be duplicates of each other. If it was thought best to employ high pressure and the most economical system of expansion, the same design would be carried out on each of the six units, so that whatever engine is brought into use it would work with the highest economy attainable. To be consistent in the design, I say, this is the plan which would be followed, although the high class engines would be much more expensive to install than a type which would consume more coal. But the days when consistency in design is the main thing to be considered are long past, and the important thing in steam and electric machinery nowadays is to get the most return for money invested, whether this be for non-condensing slide valve engines which may use 50 pounds of steam per horse power per hour, or from high pressure triple expansion jacketed condensing engines which may work on 11 pounds of steam per horse power per hour. There may be some difference of opinion as to what class of engine is in the long run the most economical. Whatever this may be, it is easy to see that it is hardly worth while to install a costly engine for the sole purpose of a relay and for assistance to the main source of power during the short time when the heavy load is on, or during times of emergency, for during a large portion of the time the relay machinery is standing idle, or, at best, only partially loaded. It seems to me that these relay engines should be installed with a view to obtaining the largest amount of power with the least expenditure of money for the plant, and not with a view to economizing steam, for the question of fuel economy in this case is one of comparatively small importance. The leakages and other losses due to improper handling in a steam plant, composed of a number of units in accordance with electrical lighting practice, prove to be a serious matter, especially where the plant is carelessly handled. The multiplicity of parts, and the great number of valves and other complication in the connecting pipes which are required, makes it easy for such losses to go on, where in a more simple steam plant composed of only one engine they could be more easily detected and prevented. For this reason much greater watchfulness is required than in ordinary steam engineering work, and, consequently, in the absence of such watchfulness the trouble is greatly augmented. The extensive use of high pressure also contributes to increased leakages, for the reason that valves and fittings become disordered with high pressures much more quickly than otherwise, and when thus disordered the loss from leakage is much greater than with the same amount of disorder under a lower pressure. In the ordinary run of electric light stations I dare say that it would be a surprise to the engineer in charge if he were to know how much steam was wasted from his plant by leakage. In almost any case if he were to shut the throttle valves of his engines, making no other change than to stop the supply of steam to the cylinders, and, at the same time, keep one of the boilers in operation with a view to maintaining the regular pressure and keeping up a supply for whatever leaks there might be, he would find that a considerable quantity of coal would still be burned to make up this loss. The leakages through throttle valves, drip valves, separator traps, stop valves for connecting pipes, and through the many other branch pipes connected with the steam system which are provided for convenience in the operation of the station, some of which might be in a disordered condition, is, under the ordinary working practice, a large quantity. Mr. Hale's paper brings this fact out, and shows that even in a plant where every precaution is taken to obtain good service, as evidenced in the Edison Company's work, the same trouble exists, and it is of vital importance. There is another point which concerns the economy of the boilers, and that is the loss due to banking fires. A fire may be banked and the boiler kept in condition for future work with very little loss of fuel, but this cannot be done unless the doors are closed and the damper is shut off so tightly that no cold air passes through from the furnace to the chimney. In the common practice this does not occur, for even with the damper nominally closed there is enough opening to produce a considerable current of cold air through the structure, and the result is that the boiler is cooled down, the inrush of air burns up the coal in the bank, and the loss thus sustained must be made good by the use of fresh coal, when the boiler again requires to be set to work.

The Effects of the Products of Combustion in a Gas Engine Cylinder.

The development of the gas engine has been attended by many difficulties, and its present state has only been arrived at by a laborious process of trial and error, assisted, to a large extent, by the suggestions of those whose scientific knowledge has been directed to the subject. Indeed, the rapidity with which the gas engine has become popular is due to the fact that experimenters have proceeded less than formerly upon the blind path of trial and error. Step by step the thermal efficiency of the gas engine has been raised by introducing compression before explosion, and by increasing the piston speed, thus minimizing the transmission of heat to the jacket water. The mechanism to bring about these improvements has been subject to many changes, and for its durability and general efficiency we must thank the practical man.

In addition to the points noted, however, there is a third problem, the attempted solution of which has recently added not a little to the list of patents in connection with gas motors. We refer to the supposed effects of the products of combustion when present during an explosion. It is probable that the introduction of water gas—notably Dowson gas—as a working agent has been instrumental in drawing attention to this question, inasmuch as the explosion of this gas is entirely prevented by a comparatively small volume of its products of combustion. Further, the mean pressure in the cylinder is considerably reduced by allowing the clearance space—necessarily large—to remain filled with the products. All this we do not doubt when Dowson gas is the working agent; but we do not so readily admit that the residue from an explosion of a mixture of town gas and air has the same detrimental effect upon a new charge.

Coal gas, in the main, consists of hydrogen and marsh gas—in round numbers we may say, 45 per cent. hydrogen and 35 per cent. marsh gas by volume; the remaining 20 per cent. is made up of nitrogen, olefines, and a very small quantity of carbon monoxide and oxygen. Upon the explosion of, say, 11 volumes of air to 1 of gas (a suitable mixture for a gas engine, though theoretically about 7.5 volumes of air contain enough oxygen for combination), the hydrogen will combine with the oxygen to form a negligible quantity of water, and the volume of marsh gas is converted into the same volume of carbon dioxide. Thus, neglecting the olefines, we get a residual gas composed of carbon dioxide, nitrogen, and any excess of oxygen that may have been present. It has recently been proved that carbon dioxide is combustible at high temperatures; but, putting aside that significant fact, we know of experiments that have been made (which we intend to shortly publish), showing that with weak mixtures of coal gas and air the addition of products of combustion distinctly raise the maximum pressure of the explosion. We do not go so far as to say that there is no advantage in driving out the products of combustion from the clearance space before drawing in the next charge of coal gas, for, if this is done, the space thus cleared may be occupied by additional gas and air, increasing the heating value of the charge, and giving agreater impulse to the piston. If, now, the same volume of coal gas and air be exploded in a larger cylinder, the additional space being filled by residual gases, from the experiments quoted it is fair to deduce that the pressure produced would be practically the same as in the first and smaller cylinder.

The question seems to resolve itself into this: It is better to design an engine having a minimum size, and therefore weight, of cylinder per indicated horse power, having also special mechanism to expel the products of combustion, or to disregard an additional weight to the cylinder, and dispense with other complications? We rather incline to the latter

solution of the problem, and we say this knowing that the arrangements made for cleaning out the residual gases are often entirely upset by subsequent alteration to the exhaust pipes; we refer more particularly to the back pressure which may be produced in the exhaust by attaching to it an exhaust box or silencer. Indeed, we know that a remarkably high thermal efficiency has been obtained from an engine fitted with exhaust pipes that entirely prevented the action of the scavenger stroke. We are much more disposed to attribute these high efficiencies to a high jacket water temperature than to any special arrangements for cleaning out the residual gases.

It must be understood that these remarks are strictly confined to engines worked by coal gas. Even with this reservation our deductions will no doubt meet with considerable opposition. It must be admitted that it is extremely difficult to imitate the conditions of a working gas engine cylinder, and in no independent experiments has this been faithfully done. There are, however, conditions which may be eliminated for the purpose of experiment, without entirely vitiating the results.

Subjects for Prize Papers, Institution of Civil Engineers, England.

At the instance of Mr. James Forrest, Secretary of the Institution of Civil Engineers, 9 Great George street, Westminster, S. W., London, England, we print the following self-explanatory circular, issued by the Institution, August, 1895:

The Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose, the particulars of which are as under:

1. The Telford fund, left "in trust, the interest to be expended in annual premiums, under the direction of the Council." This bequest (with accumulations of dividends) produces a gross amount of £235 annually.

2. The Manby donation, of the value of about £10 per year, given "to form a fund for an annual premium or premiums for papers read at the meetings."

3. The Miller fund, bequeathed by the testator "for the purpose of forming a fund for providing premiums or prizes for the students of the said Institution, upon the principle of the 'Telford fund." This fund (with accumulations of dividends) realizes nearly £140 per annum. Out of this fund the Council has established a scholarship—called the "Miller scholarship of the Institution of Civil Engineers"—and is prepared to award one such scholarship, not exceeding £40 in value, each year, and tenable for three years. No paper will be received from a student in competition for the Miller scholarship and the Miller prizes when he has become qualified by age (viz., 25 years) for election into the corporation.

4. The Howard bequest, directed by the testator to be applied "for the purpose of presenting periodically a prize or medal to the author of a treatise on any of the uses or properties of iron or to the inventor of some new and valuable process relating thereto, such author or inventor being a member, graduate or associate of the said Institution." The annual income amounts to nearly £15. It has been arranged to award this prize every five years, commencing from 1877. The next award will therefore be made in 1897.

5. The Crampton bequest of £500, free of legacy duty, has been invested in the purchase of £512 15s. 11d. 2¾ per cent. consols, and the income arising therefrom is now £13 14s. This trust is for the purpose of founding "a prize to be called the 'Crampton prize,' so that the interest of the said legacy shall be annually expended in a medal or books or otherwise * * * for presentation to the author of the best paper on 'The Construction, Ventilation and Working of Tunnels of Considerable Length,' or, failing that, then on any other subject that may be selected."

6. The balance of the Trevithick memorial fund, amounting to £100 0s. 9d., has been accepted for a periodical premium to be called after Richard Trevithick. This sum has been placed in £103 2¾ per cent. consols, upon which the interest is £2 15s. a year.

The Council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from members of the Institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors.

List.

1. The most economical methods of handling large masses of excavation, as exemplified in modern canal construction.
2. The measures necessary for the improvement of canal navigations.
3. The methods adopted in carrying out large dock and harbor works, with descriptions of the plant employed.
4. The appliances for dredging and for removing rock in deep water, with details of the time occupied in the various operations.
5. The application of compressed air, steam and hydraulic power to rock drills.
6. The construction, equipment and working of light or economical railways of a permanent character.
7. The design and construction of railway carriages, having reference to (*a*) lavatory accommodations, (*b*) provisions for refreshments, and (*c*) sleeping arrangements.
8. The use of compressed air in subaqueous tunneling.
9. The modern methods of pumping compared as to cost and efficiency.
10. The use of steel in the construction of large water tanks.
11. The employment of storage reservoirs in irrigation and in the conservation of rivers.
12. The purification of sewage by precipitation, filtration, electrolytic, bacteriological and chemical processes.
13. The use of ashbin refuse in towns for the production of steam.
14. The purification of large quantities of water after its use in manufactories.
15. The methods of enriching coal gas and their effect on its calorific and illuminating values.
16. The production and enrichment of water gas.
17. The methods of conveying and of using natural gas.
18. The utilization of heat (*a*) generated in the compression of air and other gases; (*b*) carried away by steam engine condenser water; and (*c*) contained in boiler furnace flue gases.
19. The methods of condensing steam by the use of moderate quantities of water.
20. The methods of removing moisture from steam, and of reducing losses by radiation from steam pipes.
21. The production and use of superheated steam.
22. The theory and development of the compound steam turbine.
23. The recent developments in gas engines and oil engines, including a comparison of the relative merits of the several cycles, with reference to "after-burning."
24. The application of oil and gas engines to tractive purposes on common roads and on tramways, and to the propulsion of vessels.
25. The design and construction of large turbines.
26. The methods of testing the lubricating values of oils, greases, etc.
27. The comparative merits of blast and reverberatory furnaces.
28. The influence of carbon on iron.
29. The magnetic properties of iron and steel.
30. The manufacture of steel for structural purposes.
31. The strength of steel shafts, tubes and cylinders.
32. The mining of thin seams of coal.
33. The underground arrangements in collieries.
34. The influence of coal dust in contributing to colliery explosions.
35. The efficiency of centrifugal fans for forced draught and for the ventilation of mines.
36. The drainage of mines by pumping and by tunneling.
37. The extraction of metals from their ores by electrolytic processes.
38. Argentiferous lead smelting in water jacketed blast furnaces.
39. The methods of gold mining in California.
40. The occurrence, production and uses of (*a*) asbestos, (*b*) arsenic, and (*c*) mercury.
41. Aluminum, its manufacture, properties, uses and alloys.
42. The metallurgy of chromium, molybdenum and other rare metals, and their use in the manufacture of steel.
43. The design, construction, erection and working of modern stamp mills.
44. The machines for raising mineral tailings, as lifting wheels, pumps, dredgers, etc.
45. The most suitable steam power equipments for electric light stations.
46. The utilization of electric lighting plant during hours of small demand.
47. The utilization of electrical energy in the form of heat.

48. The regulation of electric pressure in large lighting circuits as carried out at the engine, the dynamo or the exciter.

49. The theory and practice of the transmission of power by alternating currents.

50. The use of electrical motors for driving machines in textile factories and in engineering workshops.

51. The first cost, facility and economy of operation of electrical traction on railways with heavy trains, and on tramways.

52. The construction and working of electrical lifts and cranes.

53. The electrolytic action of return currents in electrical tramways on gas and water mains, and the best means of providing against electrical disturbances.

54. The most suitable alloys for the working parts of pumps for lifting corrosive liquids from mines, etc.

55. The methods of preventing or arresting the corrosion of hydraulic rams of large diameter.

56. The use of the die press in workshop operations.

57. The modern rolling mills of the United States.

58. The appliances used in the manufacture of smokeless powder.

59. The transport, storage and manipulation of grain.

60. The different systems of refrigeration, and of appliances for the storage and preservation of food produce.

61. Brine pumping and the manufacture of common salt.

62. The present limits of speed at sea.

63. The most recent types (*a*) passenger and mail steamers; (*b*) cargo steamers.

64. The relative advantages of single screws, of twin screws, and of triple screws in large vessels.

65. The use of electrical machinery for lighting and the transmission of power in warships and in the mercantile marine.

66. The best position for torpedo discharging tubes on large vessels, with a fixed direction, or trainable.

Instructions for Preparing Original Communications.

In writing these essays the use of the first person should be avoided. They should be legibly transcribed on foolscap paper, on one side only, leaving a margin on the left side, in order that the sheets may be bound. Every paper must be prefaced by an abstract of its contents not exceeding 1,500 words in length.

Illustrations, when necessary, should be drawn on tracing paper, to as small a scale as is consistent with distinctness, but in no case should any Fig. exceed 6½ inches in height. When an illustrated communication is accepted for reading, a series of diagrams will be required, so drawn and colored as to be clearly visible at a distance of 60 feet. These diagrams will be returned.

Papers which have been read at the meetings of other societies, or have been published, will not be accepted. According to the by-laws, every paper presented to the Institution is deemed to be its property, and may not be published without the consent of the Council.

The communications must be forwarded to the Secretary, from whom any further information may be obtained. There is no specified date for the delivery of MSS., as when a paper is not in time for one session it may be dealt with in the succeeding one.

WILLIAM POLE, Honorary Secretary.
JAMES FORREST, Secretary.

The Institution of Civil Engineers,
Great George Street, Westminster, S.W., August, 1895.

Excerpt By-Laws, Section XV., Clause 3.—"Every paper, map, plan, drawing, or model, presented to the Institution shall be considered the property thereof, unless there shall have been some previous arrangement to the contrary, and the Council may publish the same in any way and at any time they may think proper. But should the Council refuse or delay the publication of such paper beyond a reasonable time, the author thereof shall have a right to copy the same, and to publish it as he may think fit, having previously given notice, in writing, to the Secretary, of his intention. Except as hereinbefore provided, no person shall publish, or give his consent for the publication of any communication presented and belonging to the Institution, without the previous consent of the Council."

Notice.—It has frequently occurred that in papers which have been considered deserving of being read and published, and have even had premiums awarded to them, the authors have advanced somewhat doubtful theories, or have arrived at conclusions at variance with received opinions. The Council would therefore emphatically repeat that the Institution as a body must not be considered responsible either for the statements made, or for the opinions expressed in the papers or in the consequent discussions; and it must be understood that such papers may have medals and premiums awarded to them, on account of the science, talent or industry displayed in the consideration of the subject, and for the good which may be expected to result from the inquiry; but that such notice or award must not be regarded as an expression of opinion on the part of the Institution of the correctness of any of the views entertained by the authors of the papers.

The Proportion of Inflammable Gas Necessary to Produce a Mine Explosion.

At a meeting of the Federated Institutions of Mining Engineers, held in London, Dr. Clowes, in a paper on the above subject, stated that the connection of his name with the process of accurately testing for small quantities of inflammable gas in the air has led to frequent inquiries being made from him regarding the proportion of an inflammable gas in the air which will cause explosion when it is fired. He has thus been led to undertake experiments with the object of determining this proportion. It is evident that there will be some one proportion of an inflammable gas in air which will lead to the most violent explosive effect when the mixture is kindled. But it is known that mixtures containing both larger and smaller proportions of the gas are also capable of being exploded by contact with a flame. The object of the series of experiments, the results of which are here described, was to determine the least proportion of the gas and the largest proportion of the gas, which, when mixed with air, are explosive at ordinary atmospheric pressure. These are termed the limiting explosive mixtures. The mixtures were made in a glass cylinder of known capacity, 3 inches in diameter, and closed at one end. The jar was filled with water, and was then inverted with its open mouth in a pan of water. The measured volume of air was introduced into the cylinder, and the remainder of the water was then replaced by the combustible gas. A small xylonite ball was then passed up into the cylinder, the mouth of which was closed with a glass plate. After the closed cylinder had been removed from the water, the air and gas were thoroughly mingled by causing the ball to run up and down inside. The cylinder was then removed into a dark room, and a small Bunsen atmospheric gas flame was brought to its mouth. If a sheet of flame traveled quickly through the whole length of the cylinder, the mixture was considered to be combustible independently of the external atmosphere. Such a mixture, though it burnt silently in the small mass contained in the cylinder, would undoubtedly produce explosive effects if it was kindled in larger quantity. If the mixture refused to kindle in contact with the flame, or if it simply burnt slowly from the mouth of the cylinder as the external air reached it, it was considered to be non-explosive at ordinary atmospheric pressure. It was found that the mixtures were more readily kindled upward by a flame placed below them than downward by a flame placed above them. Accordingly, the composition of the limiting explosive mixtures varied with the mode of firing. The experiments were carried out with several different combustible gases and with coal gas. The limiting explosive mixtures varied in composition with the different gases employed. In order to accurately measure small volumes of inflammable gas in making the mixtures, the gas was diluted with nine times its volume of air. In this way a tenfold volume could be dealt with. Allowance was made for the air thus introduced with the gas in calculating the composition of the mixture to be experimented with. The results obtained by repeated experiments made with the same gas were concordant. In every case the next percentage of gas, below or above, as the case may be, failed to fire back. The results obtained are tabulated below:

Limiting Explosive Mixtures of Various Gases with Air.

Combustible Gas Used.	Percentage of Gas Mixed with Air. Lower Explosive Limit.	Upper Explosive Limit.	Method of Kindling.
Methane or marsh gas.	5	13	Upward.
	6	11	Downward.
Coal gas	5	28	Upward.
	9	28	Downward.
Water gas	9	55	Upward.
Hydrogen	5	72	Upward.
Carbonic oxide	13	75	Upward.
Ethylene	4	22	Upward.

The conclusions drawn from the above results are as follows: 1. When mixed with atmospheric air at ordinary atmospheric pressures, different combustible gases show different limiting explosive proportions. 2. The range between the lower and upper explosive mixtures is least in the case of methane or firedamp. The range is widest in the case of hy-

drogen, but carbonic oxide shows an almost equally wide range. The limits in the case of water gas are widely separated; with coal gas the range of explosibility is less. 3. The tendency to explode is greater when the mixture is fired from below than when it is fired from above. Hence the lower limit mixture contains less gas, and the upper limit mixture contains more gas when the mixture is fired below than when it is fired above. 4. Since the risk of explosion occurring when a gas is mixed in unknown proportion of air is diminished as the limits of explosibility approach one another, the gases which were employed in these experiments may be placed in the following order of increasing danger: Marsh gas, ethylene, coal gas, water gas, carbonic oxide, hydrogen. 5. In every case the danger of explosion resulting from a naked flame being brought into contact with a mixture of unknown composition is greatest when the flame is applied to the bottom of the mixture than when it is applied to the top. 6. It is interesting to note that Mr. Lewis T. Wright, when firing a mixture of coal gas with air in a horizontal tube, obtained, as limiting explosive proportions of gas, 10.3 and 23 per cent. respectively. The lower and upper limits of horizontal explosion here correspond with those obtained by the writer for vertical downward explosion. They differ considerably from the limits for upward explosion. Hence it appears that horizontal kindling corresponds in its general character with downward kindling. It is not to be classed with upward kindling.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

IT is thought by those concerned that the suit of the authorities of Malden, Mass., against the Malden and Melrose Gas Company, for damages alleged to have been occasioned to the sewers of Malden, because of an explosion of gas that escaped from leaky mains of the Company, will be settled out of court.

A CORRESPONDENT writes: "On the evening of Thursday, September 26th, gas was turned for the first time into the pipes in the streets of Pelham Manor, N. Y., and the resulting public lights (84 in number) were greatly admired. The lanterns are fitted with Welsbach burners, and I have no hesitation in saying that it was the best exhibition of street lighting, at once effective and economical, that I have ever seen. If I am not mistaken Pelham is the first town in this country to be lighted exclusively with Welsbach burners. There is only one objection to the Pelham lighting that can be fairly instanced—the authorities have not decreed that every street should at once be thus illuminated; however, as I understand it, they propose to remedy this defect in short order. For, certainly, the sample they have before them speaks for itself.—G."

PELHAM, the place referred to by our correspondent, is in the annexed district of New York City, and its gas supply has just been laid on by the American Gas Company, which controls the territory between Mount Vernon on the west and New Rochelle on the east.

THE municipal faddists of the Pacific Coast have for their ally a "band of brothers," and the name of the band is this, "The Union for Practical Progress." The headquarters of the band is in San Francisco, and the "band's" preliminary or tuning appeal for recognition is pitched in the appended key:

"To the Honorable Mayor and Board of Supervisors of San Francisco—We, your petitioners, residents and voters in the city and county of San Francisco, State of California, respectfully ask that a special election be called and held for submitting to the voters of this city and county the question of municipal ownership of the water works, gas works and electric lighting plants which are now using our streets. We request that at the election which you are asked to call, the voters be allowed to signify their assent or disapproval (in conformity with Article XI., Sec. 18, of our Constitution) of the incurring of such indebtedness as may be found necessary to provide this city with a sufficient, adequate and proper water, gas and electric light supply. We request that all work undertaken shall be under the direct control of the city, and that as far as possible California products shall be used, if said undertaking receives the assent of the voters of this city and county. Requesting your favorable and prompt action, we subscribe ourselves."

"CALIFORNIA products," eh! There are so many of them that it would be a hard matter to make an appropriate selection when it comes to making gas, for instance. Else why should the San Francisco Gas Company buy its coal in Washington or other "foreign parts," and have to look to Mr. Flint or to the Standard Oil Company for its oil? Quality, price and surety of supply look to us to be the reasons that impel the San Francisco gas makers.

THE shareholders of the Tonawanda (N. Y.) Gas Light Company have assented to the proposition to place a mortgage amounting to $9,000 on the plant. The Buffalo Loan, Trust and Safe Deposit Company is to advance the sum named.

THE Oshkosh (Wis.) Company's new purifying plant is to be housed in a new building located on a plot in the rear of the works. The building is of brick, two stories in height, and its ground dimension is 35 by 60 feet. Four boxes are arranged for, and the total cost of the improvement is put at $5,000.

THE organization of the Citizens Gas and Fuel Company, of Terre Haute, Ind., is to be maintained, just for purposes of safety. The executive management is: Directors, Messrs. H. Hulman, John D. McIlhenny, A. Hulman, A. Z. Foster, W. R. McKeen, Willard Kidder and H. P. Townley; President, John D. McIlhenny; Secretary and Treasurer, J. B. Harris; Superintendent, M. N. Diall. Judging from the names above given there is not likely to be much conflict between the Citizens Company and the old Terre Haute Company.

THE following figures respecting the number of meters in use and the output of the Jamaica Plain (Mass.) Gas Light Company for the years noted are official—the Company's fiscal year ends June 30th: Gas sold, 1894–5. 53,109,589 cubic feet; meters in use, 2,337. Gas sold, 1893–4, 49,377,242 cubic feet; meters in use, 1,962. Gas sold, 1892–3, 43,646,579 cubic feet; meters in use, 1,795.

THE Boston *Post*, of September 30th, says that it is a certainty that the Brookline (Mass.) Company has passed into the hands of the Bay State Company, and as soon as certain arrangements are perfected an absolute ownership can be claimed by the Bay State Company.

THE new holder for the Danville (Ky.) Gas Light Company is to have a capacity of 20,000 cubic feet.

THE current law reports from Baltimore, Md., contain the particulars of an interesting decision handed down on September 25th by Judge Phelps in the City Court, in the case of Lewis N. Hopkins, Tax Collector, against Mrs. Camilla Simpson and Edward Simpson, her husband. The suit involved the constitutionality of the State act of 1884, Chapter 234, embodied in the present Maryland code as Section 88, Article 81. The Collector taxed 12 bonds of the Consolidated Gas Company held by Mr. Simpson. Payment of the tax was resisted on the ground that the law having exempted certain other mortgage bonds and mortgages, such as homestead or building society mortgage debts and mortgage debts of individuals, mortgage debts of corporations, as evidenced by the bonds in question, under the rule of uniformity by the 15th article of the bill of rights, should also be exempt. In reply to this contention, City Counsellor Thomas G. Hayes claimed that the power of the Legislature to discriminate in the matter of exemptions of debts, if not arbitrary, was conclusive and final; and further, that if it were a judicial question there were good and solid reasons why the one should be exempt and the other taxed. If the market value of the stock and its bonded indebtedness were taken as the standard of taxable value, he said, the taxable bonds of the Consolidated Gas Company should be $11,887,500, while in fact this Company was taxed only on a valuation of $5,169,930, thus permitting $6,717,570 to escape. This amount that escaped, Mr. Hayes claimed, was just about the bonded indebtedness which was attempted to be taxed in the hands of the holders, and if not so taxed the whole amount of the $6,717,570 could pay no part of the burdens of government. Judge Phelps decided in favor of the plaintiffs, and we hope at another time to give the text of his opinion.

AT a special term of the Supreme Court, held at Albany, N. Y., on the 23d September, Justice Alton B. Parker, of Kingston, presiding, the Court ordered, in the matter of the petition and writ of certiorari served upon Comptroller James W. Coffey, on the application of the Troy Gas Company, to show cause why an assessment of $540,800 for personal property made against the Company should not be removed from the assessor's books, the return of the writ to be made at the special term, at Troy, last Saturday.

THE new holder for the American Light and Heat Company, of Hagerstown, Md., will be complete in a fortnight. Its capacity is 75,000 cubic feet, and insures to the Company ample storage facilities.

THE special committee appointed by the City Council, of Richmond, Va., to "fully investigate the affairs of the Gas Department," has organized. The Chairman of the Committee is Mr. Gunst, and the scheme so far outlined provides that an expert accountant shall be employed to go over the accounts kept during the entire period when the late Mr. Adams was Superintendent of Works; also, to prepare a comparative statement of the accounts for a like number of years prior to the time Mr. Adams assumed charge.

A CORRESPONDENT at Wheeling, West Va., writing under date of September 28th, says that the next Board of Gas Trustees will likely be of the following personnel: Dr. H. T. Ford and Messrs. E. Buckman and Julius Pollock. The political complexion of the Board is Republican, the two first named affiliating with that party, while Mr. Pollock is a Democrat. The law framing the Board provides that one member of it shall be of the minority party.

MR. J. W. BELL, of the Bridgewater (Pa.) Natural Gas Company, and Mr. W. J. Carnes, have appealed from a judgment imposed upon them by a local authority, under which they were fined $25 for "performing worldly employment on Sunday." Their defence was that they had to pump their oil wells to prevent them from being flooded; and to the ordinary mind this would seem to be a perfectly valid defence.

THE St. Thomas (Ont.) Gas Company is overhauling and enlarging its main system.

AT the annual meeting of the Brookline (Mass.) Gas Light Company the old Board of Directors was re-elected. The ballot represented 14,250 shares out of a possible 20,000.

SOME time ago we reported that Mr. J. D. Young, City Auditor of Sacramento, Cal., had refused to audit a bill for $25.80 for gas consumed in one of the public buildings of that city, which gas had been supplied in the regular way by the Capital Gas Company, of Sacramento. The basis of the refusal was that the bill had been improperly audited by Mr. Steinmann in his capacity as Mayor of Sacramento, who through this certification was adding to the profits of the Capital Gas Company, of which Company he is President. The Company applied for a writ of mandate to compel the Auditor to pass the bill and the writ was granted. From this mandate the Auditor appealed to the Supreme Court, which tribunal eventually pronounced the following decision: "The Capital Gas Company, a corporation organized and existing under the laws of the State of California, is and for more than 12 years last past has been engaged in the business of furnishing gas to the residents of the city of Sacramento (a municipal corporation) and to consumers generally for profit, and has had shares of stock issued to and held by divers persons, and C. H. Cummings is, and for more than one year last past has been, the duly appointed and acting Secretary of said corporation. The said corporation has, during a period of more than 12 years last past, been engaged in said business under and pursuant to certain franchises duly granted to it by said city of Sacramento. On the 11th day of January, 1882, the Board of Trustees of said Capital Gas Company, by resolution regularly passed, fixed the prices to be paid by consumers thereof at $3 for each 1,000 cubic feet. J. D. Young, the appellant herein, is, and for more than three years last past has been, the duly elected and qualified Auditor of said city of Sacramento, and under the provisions of the charter thereof duly adopted it is the duty of said Auditor to draw and sign all warrants upon the treasury for claims against said city which have been allowed by the Board of Trustees thereof. The Fire Department is, and for more than one year prior to 1894, was one of the departments of the municipal government of the city of Sacramento. At all the times herein mentioned B. U. Steinmann was and still is the holder and owner of stock in said Capital Gas Company, and was and still is the President of said Company, and since the first Monday in January, 1894, has been and still is the duly elected, qualified and acting Mayor of said city of Sacramento. Between the first day of February, 1894, and the first day of March, 1894, the Fire Department of the city of Sacramento used and consumed 8,600 cubic feet of gas furnished and distributed by the Capital Gas Company, which gas, according to the rate fixed as aforesaid, was of the value of $25.80, and thereafter and on the 1st of March, 1894, the said Gas Company presented its bill therefor in said amount, duly itemized and verified, to the Board of Trustees of said city, which bill was allowed by said Board for said sum of $25.80, and presented to the Auditor aforesaid, who rejected the same and returned it to the Board as provided by the charter. Thereafter the said bill was again allowed and approved by the Board of Trustees and by B. U. Steinmann, the Mayor, in due form, and was again presented to the Auditor, who refused to audit the same or to draw his warrant therefor on the Treasurer of said city in favor of the said Gas Company. Said sum of $25.80 is still due and owing from the said city to said Gas Company. The gas so furnished was not furnished under any express contract, nor was it furnished pursuant to any contract entered into before the election of said Mayor, except that it was furnished pursuant to the franchises of the said Gas Company and the law applicable to said Company. The decision then quotes section 211 of the city charter, which provides that no member of the Board of Trustees or officer or employee of the city shall be or become directly or indirectly interested in or with the performance of any contract, work or business, or in the sale of any article, the expense, price or consideration of which is payable from the City Treasury. Upon the facts as found by the Court, of which the foregoing is a condensed statement, the Court below adjudged that an alternative writ of mandate therefore issued in the case be made peremptory, requiring the appellant herein as Auditor to issue his warrant upon the treasury of the city of Sacramento, and upon the proper fund therein, for the amount of the demand, viz., for $25.80. The defendant Auditor, as aforesaid, appeals from the judgment and the cause comes up on the judgment roll. The officers of a municipal corporation, like those of private corporations, are agents of the corporate body. It is a cardinal doctrine of the law of agency that whenever an agent is invested with authority to use any discretion in the exercise of the power conferred upon him it is an implied condition that this discretion shall be used in good faith for the benefit of the principal and in accordance with the true purpose of the agent's appointment. To this extent every agency which is not a purely ministerial one invokes a fiduciary relation between the parties. (Morawetz on Private Corporations, Sec. 516.) It is in consonance with this principle that officers of a corporation may not, under any circumstances, use their official position for their own benefit or for the benefit of anyone except the corporation itself, and they may not represent the corporation in any contract or transaction in which they are personally intrusted in obtaining an advantage at the expense of the corporation. In such cases it is said the corporation would not have the benefit of their unbiased judgment, as self interest would prompt them to prefer their own advantage to that of the Company. (San Diego vs. S. D., etc., Co., 44 Cal. 106; Shakspear vs. Smith, 77 Cal. 638; Finch vs. Riverside, etc., Co., 87 Cal. 597; Wickersham vs. Crittenden, 93 Cal., 29; Capron vs. Hitchcock, 98 Cal., 427; Dillon on Municipal Corporations, sec. 444.) The rule embodied in the foregoing decisions, and which has the support of a host of others which might be mentioned, is not an arbitrary one. In other words, it is founded in reason, and is not to be indiscriminately applied irrespective of the circumstances of the case. (Morawetz, sec. 521.) It would seem that the circumstances of the present case bring it within the exceptions, for the following reasons: 1st. The authority to transact the business of the municipal corporation of the city of Sacramento, to procure supplies therefor, and to audit and allow claims against the city is vested in the Trustees, and B. U. Steinmann, as Mayor of the city, has not, so far as appears from the record, any authority in the premises. 2d. The gas furnished to the city was not supplied under or pursuant to any express contract with the respondent corporation of which Steinmann is President, and the right to recover the reasonable value thereof is based upon the implied promise which the law raises. 3d. Under section 629 of the Civil Code the respondent was bound upon proper demand to furnish gas to the city, and upon refusal so to do was liable to a penalty of $50 as liquidated damages for each day such refusal or neglect continues thereafter. Under operation of this law the Gas Company was not a free agent with power to contract or refuse to do so, but it became its duty upon demand to furnish gas to the city, irrespective of the status of its President. This duty to furnish gas to the city devolved upon the respondent, not by virtue of any contract, but by operation of law, and hence the laws governing ordinary contracts resting in the volition of parties thereto has no application. Where the law affixes a penalty for the non-performance of an act, its performance should not be adjudged illegal or subject the party performing to the implication of having violated a duty. Had the city of Sacramento been in need of the land of its Mayor pursuant to some public use, and had it, by proceedings for the condemnation thereof under the law of eminent domain succeeded to the title, the proceeding would have been so far an adversary one that there could have been no liability on the part of such Mayor for a violation of section 211 of the city charter, which inhibits its officers from being interested in any contracts or sales to the city involving the payment of money from its treasury, or from being inter-

ested in any franchise, right or privilege granted by the city while they are in office, is, except as to the penalty imposed thereby, in substance, a declaration of the common law as it previously existed, and is founded in wisdom and justice. It is intended as a shield to the city against the selfishness and greed of officials, but was not intended any way to be used as a medium by which the city can take the property of others without their consent under form of law, and then refuse to pay therefor its reasonable worth because an officer of the city is interested in such property. We hold that section 211 of the city charter has no application to a case like the present, where the Gas Company is required by positive law to furnish gas to the city upon demand, and having furnished the commodity, has presented its bill for the reasonable value thereof, although the Mayor of the city owns stock in the Gas Company and is President thereof. The city having received and used the gas pursuant to a right which it enjoyed, independent of the volition of respondent, is in equity and conscience bound to pay the reasonable value thereof. The judgment appealed from should be confirmed."

Mr. J. B. Crockett, President of the San Francisco Gas Light Company, arrived home some days ago.

It is said that the consolidation of the Union Electric Light Company, of Seattle, Wash., and the Seattle Gas and Electric Light Company, has been dissolved by mutual consent. The latter Company will, in addition to the supplying of gas, furnish electric currents for arc lights, and has established headquarters in the Rialto Building, corner of Second and Spring streets.

Researches with the Alternating Current Arc.

In a paper by Mr. Georges, printed in the *Electrische Zeitung* for August 22d, the author reports the results of a large number of experiments made with the alternating arc by Mr. Oelschlaeger, Dr. Michalke and Mr. Queisser. Regarding the frequency, he states that the limit at which the pulsations can be noticed by the eye is a frequency of 60; at 40 the light is still unbearable, and at 50 the pulsations may still be noticed; a ground glass globe or a reflector will make the pulsations less perceptible. The length of the arc has an important effect on the light for the same amount of energy. On account of the shadows of the carbons, the length of the arc must not be made too small. The temperature of the carbons is greatest when they are nearest together. Curves are given showing the light given out at various angles for different lengths of arc and for the same amount of energy, the curves being reduced to the number of candles per watt. The form of the current curve has a very great effect on the arc, and as the armature reaction affects the curve form, it is preferable in making such researches to use large machines. Different forms of current curves may be obtained by making different connections in 3-phase machines, and this means was used in the present researches. The noise made by the lamp depends very greatly on the form of the curve; with a sine curve the note is soft and musical; with curves in which there are sudden changes, overtones and impure notes were reproduced; there is besides this a much more disagreeable noise depending on the curve form and on the nature of the carbons; this occurs most frequently with pointed curves, less with flat, and seldom with sine curves; with some carbons it is impossible to get rid of it, while with others this noise is never produced.

The voltage of the arc is dependent on the current curve; with the alternating arc the voltage must reach a definite value in order to relight the arc; this must be greater the more pointed the current curves; but, in spite of this, the mean voltage of the pointed curve is less than that for flat curves. They found that for a 2 mm. arc and a pointed curve 23.5 volts were required, and with a flat curve 30.5; the voltage must therefore be chosen in accordance with the current curve, and it is therefore not possible to adjust such lamps in the factory. The higher voltage of the flatter curves may be preferred, as the lamps then take less current.

The temperature of the points, and, therefore, the candle power, is determined chiefly by the energy consumed. At very great frequencies the light is probably independent of the current curve. In the frequencies used in practice the light is greater the flatter the current curve; they found, for instance, for a 12-ampere lamp the mean spherical intensity per watt was 0.96 candles for a flat curve and 0.796 for a pointed curve.

The better efficiency of the flat curves might be explained by the fact that with pointed curves there is a longer time when the current is small, and during this time the carbons will cool and the light diminish. It might be said that the eye may possibly measure the light by a different mean value, just as a dynamometer does not measure the algebraic mean of a current. He then describes a number of photographic measurements of the light, measured momentarily. A synchronous motor was used which revolved a disc with a slot, behind which was placed some sensitive paper; the results are given in the form of rings varying in darkness in the different parts, each portion of the paper being illuminated only by one particular phase. The tests were repeated with opal globes and reflectors; some of these show that the light still varies with the current for frequencies as high as 300 per second.

Successive photometric measurements of the light for a complete period were made, together with measurements of the current and the voltage curves, for flat, pointed and sine curves, the results being given in the paper in the form of curves.

The photometric measurements were made with a disc having a slot, and rotated by means of a synchronous motor; in front of the movable disc was a fixed disc having a similar slot, and the light was measured only at the moment when it passed through both slots; instead of moving the slot to different positions, the current for the motor was transformed in a three-phase motor, the stationary part of which was supplied from the same machine which ran the lamp, while the current induced was used to drive the synchronous motor; any phase shifting can then be produced by changing the position of the part in which the current is induced. The resulting curves show, among other things, how little the negative maximum exceeds the two minima; the positive minimum is quite great; during the time of the greatest current there is an accumulation of heat shown by an increase in the light; this is specially noticeable with the flat current curve diagram.

The phase shifting between the voltage and current is decidedly positive near the zero line—that is, as if it was produced by a self-induction; it is also clear that for the higher values of the current there is a negative shifting; for the flat curves the current and light curves are shifted toward the left in relation to the voltage curve, which might be explained by the assumption of thermo-electric counter forces in the arc; for the greater currents there is a greater difference of temperature between the carbons, and the thermo-electric force is therefore greater at the positive carbon, and generates an E.M.F. which is opposed to the current, and hence diminishes it. The curve should not be used to compare the efficiencies of the arc for different current curves, as the former are only approximately correct.

In the discussion which followed Mr. von Dobrowlsky called attention to the fact that the current curves do not remain at zero any appreciable time, which is contrary to the assumption that the arc is re-lit at each alternation. Mr. Webber suggested that it is quite probable that the hot air conducts directly and that the current can pass through it without forming an arc. He suggests that the results obtained might be quite different if different carbons were used, as he found, for instance, that for the same current of 6 amperes and equal arcs of 2 mm, the number of watts was 142 with two cored carbons and 266 with two solid carbons; with a cored carbon at the top 168, and with a cored carbon at the bottom 159 watts. He states having measured the phase difference produced in the arc the results being obtained by measuring the energy in a watt meter and taking the difference between that and the product of the volts and the amperes; with two cored carbons it was nearly zero, while with two solid carbons and for a hissing arc the phase difference was 42.5°, for the quiet arc 35°, while with a cored and a solid carbon it was 24°; the arc is therefore quite different, depending on the carbons. In the tests described by Georges, cored carbons were used.

Mr. Meissner stated that the effect of the heated gases can be readily shown in starting a continuous current arc, when it will be found that after it has burnt for some seconds the carbons can be pulled apart much farther than before. When a porcelain or slate rod was introduced in the arc through the center of the carbons, the length of the arc could be made five or six times as great for the same voltage, showing that the conductivity of the gases affects the length of the arc. Similar results were referred to in connection with the blowing of fuses. Mr. von Dobrowlsky doubted the correctness of the large phase shifting noticed by Webber and attributed it to errors in the instruments, which, however, Webber refutes, stating that Prof. Ayrton had obtained similar figures. That hot gases conduct was doubted by some, but Webber thought there was no doubt, and referred to the results of Pringsheim. Mr. Georges believes that the tests leave little doubt that there is a counter E.M.F. in the arc, a point about which there was some discussion.

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MONDAY, OCTOBER 7, 1895.

Gas Distribution Needs in Philadelphia

The Director of Public Works of Philadelphia (Mr. Jas. H. Windrim), in his report to Mayor Stuart, noting the operations of the Gas Bureau for the year ending December 31, 1894, among other things says: From the report of the Chief of the Bureau of Gas (Mr. W. K. Park), it will be noted that the percentage of leakage during the past year has largely increased. The unusual increase at this time has been occasioned to a great extent by the renewal of many miles of pipes prior to the repaving of streets and the loss from the mains consequent to this work. The increasing percentage of leakage each year is due to the insufficient size of many of the distributing mains which are extended in length from year to year, as the growth of the city makes it necessary to supply gas in new territory; to reach these extreme distances requires greater pressure at the works or holder stations, which increases condensation in the pipe lines and forces leakage from joints which might not leak under less pressure. This condition implies that additional holder stations would shorten the distance that gas has to flow in supplying specific districts; that blowers may be inserted in the circuit of the present mains to assist the distribution; or that the mains should be sufficiently increased in size to pass freely the volume of gas required in any section with the least pressure at the works or holder stations. The minimum percentage chargeable to leakage will be obtained when mains are of adequate size to deliver the amount of gas required with the least resistance, at the lowest pressure, and with the joints in the pipe lines kept free from leaks.

The Market for Gas Securities.

The market for Consolidated came in to day (Friday) with sales at 145½, and at noon 145⅝ was bid, holders asking 146. This is an advance for the week of 2½ points in the bid price, and from our best information it looks that higher figures are shortly to be made in it. Equitable was very strong during the week, and 197 ex. div. is freely bid, which puts it again at the double par mark. Mutual, too, shared in the tendency to higher values, and it is inquired for at 174, holders asking 178. Standard, common and preferred, are higher, and the "rights" pertaining thereto are 1½ bid, offered at 1⅝. East River specialties are dull and slow. The Brooklyn situation is still muddled, although it is understood that the snag of last month is about cut out. Some changes have occurred in the counting room of the Citizens Company, of Brooklyn, and we also understand that Mr. Tudor has resigned his dual position therewith. A plan for the legal rehabilitation of the Chicago Trust interests has been formulated, and the belief is that it will stand the test of law. Meanwhile the bid price for the shares is well above 72. Consumers, of Jersey City, is 91½ bid, and the bonds are quoted at 102. Western, of Milwaukee, is firm, at 69½ to 71. The Bay State Company, of Delaware, is proposing to issue ten millions more stock, the proceeds of which issue, some say, are to go towards paying for the acquisition of the Brookline Company, while others insist that the money is to acquire the gas plants at Buffalo, N. Y. It does not matter much, however, to real investors whether this or that is so. Meanwhile Bay State, of Boston, is dull, at 19 to 20.

Gas Stocks.

Quotations by Close & Nash, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

OCTOBER 7.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	145½	146
Central	500,000	50	150	..
" Scrip	230,000	..	100	..
Equitable	4,000,000	100	197x	..
Bonds, 6's	1,000,000	1,000	106	..
" 1st Con. 5's	2,300,000	1,000	113	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	174	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	.
Northern	150,000	50	90	91
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	29	31
Preferred	2,000,000	100	53¾	55
Bonds	3,500,000	1,000	94½	95
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	66	68x
Preferred	5,000,000	100	106	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	109	..
Yonkers	299,650	50	112	..
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	..
Citizens	1,200,000	20	65	..
" S. F. Bonds	320,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	175	..
" Bonds	300,000	..	103	..
Peoples	1,000,000	10	90	.
" Bonds, 7's	368,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	170	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	225	..
" Ctfs.	700,000	1,000	99	100
Williamsburgh	1,000,000	50	210	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	19½	20
" Income Bonds	2,000,000	1,000	..	80
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	78	80
2d " " "	3,000,000	1,000	53½	..
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	.....	..	95	..
Chicago Gas Co.	25,000,000	100	72	73½
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,089,000	..	63	66
1st Mortgage	1,085,000	..	91	98
Consumers, Jersey City	2,000,000	100	91½	93½
" Bonds	600,000	1,000	102	103½
Cincinnati G. & C. Co.	7,000,000	100	202¾	203½
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	.....	.	..	41
Consolidated, Baltimore	11,000,000	100	63	64
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,400,000	..	..	..
Detroit	4,000,000	..	30¾	..
" Con. Bonds	4,312,000	..	75	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	72	74
" Bonds	2,000,000	..	85	..
Hartford	750,000	25	130	135
Indianapolis	2,000,000	..	147	152
" Bonds, 6's	2,650,000	..	103½	..
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	84	86
Bonds	1,000,000	1,000	88	90
Louisville	2,370,000	50	..	130
Laclede, St. Louis	7,500,000	100	28¾	29
Preferred	2,500,000	100	85	87
Bonds	9,034,400	1,000	97	.
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	..
New Haven	.....	25	225	..
Oakland, Cal.	.....	..	46½	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	
Western, Milwaukee	4,000,000	100	69½	71
Bonds, 5's	3,556,000	..	93	..
Wilmington, Del.	500,000	50	188	190
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	70¾	71
St. Paul Gas Light Co.	1,500,000	100	68	70
1st Mortgage, 6's	650,000	..	..	..
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., 813 DREXEL BUILDING, PHILA., Sept. 26, 1895.

The Directors have this day declared a quarterly dividend of 2 per cent. ($1 per share), payable on Oct. 15, 1895, to stockholders of record at the close of business Sept. 30. Checks will be mailed. EDWARD C. LEE, Treas.

Position Desired

By a man 21 years of age, who has had considerable experience in the Coal and Water Gas business. Can take meters, make connections, set meters, lay mains, put in services and stoves, and do any kind of work about a gas works. Best of references. Address

1059-4 "B. R. D.," care this Journal.

POSITION WANTED

As Supt. or Manager of a Gas Works or Gas and Electric Light Works.

Fifteen years' experience as Manager of Gas Works and six years Gas and Electric Light Works. Good reasons for wishing to change present employment.

1043-tf Address "Y. B.," care this Journal.

WANTED,

By a man who has had a round experience in the manufacture and sale of gas,

A Position as Supt. of a Large or Smal' Gas Works.

Is capable and energetic, and is willing to begin at a moderate salary. Address

1062-tf "B.," care this Journal.

Gas Works For Sale

It is desired to sell a Gas Works situated in Michigan. Will be sold cheap, as present owner is compelled to remove to another State. Address

1060-3 "OWNER," care this Journal.

WANTED,

About 50 Lamp Posts of a Like Pattern

about 12 ft. 6 in. long, the top end for the reception of the lamp frame to measure 5 in. long, 2⅝ in. diameter at the top and 2⅞ in. diameter at the bottom. State price delivered in Milwaukee. Address at once,

THE MILWAUKEE GAS LIGHT CO.,
1060-2 Milwaukee, Wis.

FOR SALE,

Four 10-inch Ludlow and Two 6-inch Smith & Sayre Valves.

All in good order, and will be sold at a bargain. Address

TITUSVILLE GAS CO..
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Two 10-in. Smith & Sayre Exhausters.
One Condenser. One Washer.
Four Purifying Boxes, 10 ft. by 16 ft., with 10-inch Connections.

SPRINGFIELD GAS LIGHT CO..
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Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator,

Not Expensive. Write to

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Get Our Prices on

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For Welsbach Lights,

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Mica Canopies.

The MICA MFG. CO.,

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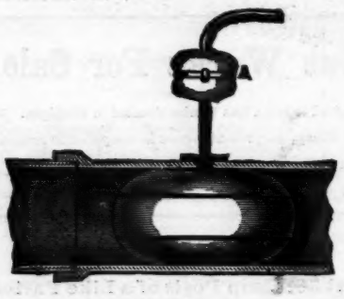
88 Fulton Street, - - New York City.

GOIN! GOIN!! GOIN!!!

should be neatly and accurately wrapped before banking. We make the *only* device that will do it properly. *Successful bankers* give these to their customers. If you prefer to buy, ask any stationer for them, or write to us for prices and free samples.

ALVORD & CO., Mfrs. **Detroit, Mich., U.S.A.**

Peerless Patent Improved Gas Bag



These Gas Bags are used to stop the flow of gas while repairing or making alterations in gas mains. There have been numerous cases of workmen being badly injured, and sometimes fatally, by the escape of gas resulting from the bursting of a bag, and our patent improvement is designed to obviate such calamities. The indicator *A* shows unerringly when the bag has been sufficiently inflated to pack the main, and when the pumping should be stopped. Our Bags are made of a rubber stock especially prepared to admit of great distension, and to resist the action of Oils, Gases, Naphtha and other residuum in the mains, and they are made with lapped joints, which adds greatly to their strength.

3-in.	Gas Bag,	each,	$0.60	12-in.	Gas Bag,	each,	$5.00
4 "	"	"	.80	16 "	"	"	8.25
5 "	"	"	1.05	20 "	"	"	12.00
6 "	"	"	1.75	24 "	"	"	17.00
8 "	"	"	2.65	30 "	"	"	27.50
10 "	"	"	3.75				

The Peerless Rubber Mfg. Co.

16 Warren St, N. Y. City.

TRIUMPH REGENERATIVE GAS HEATER

Wilder's Patents, Nov. 15 & 22, 1892.

Heats both air and gas before combustion. Gives high flame temperature and maximum economy, with entire freedom from smoke and smell. Radiates heat to the floor. Warms the feet and does not overheat the head. No headache and no colds caused by cold feet where this Heater is used. Has Group Governor, which regulates gas volumetrically proportionate to heat desired; the only correct regulation for stoves and furnaces. A gas heater, if a free gift, is still costly and extravagant if it burns gas wastefully. The Triumph Heater is constructed upon correct principles, and gives results not obtained with any other.

Write for descriptive circulars and order sample Heater.

WILDER MFG. CO., 816-822 Cherry St., Phila.

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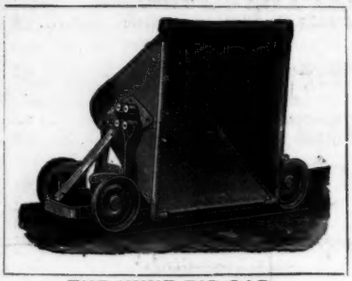

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COKE CARS for Gas Works,
TIP CARS for Carrying Ashes,
CHARGING CARS for Bringing Coal from the Storage Bins to Boiler Room and Retort Houses.

INDUSTRIAL RAILWAYS

Specially designed for handling material in and around

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The Best Boiler in the World, and the Cheapest per Square Foot of Heating Surface.

Unequaled for the Economical Production of Very Dry Steam.

WE GIVE Liberal Capacity, Highest Efficiency, Absolute Safety and Thorough Workmanship.

WE SOLICIT the Critical Examination of the Mechanical Profession and the Steam-Using Public, and Your Trade.

Send for Catalogue and Reports of Tests.

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Sole Proprietors and Manufacturers,

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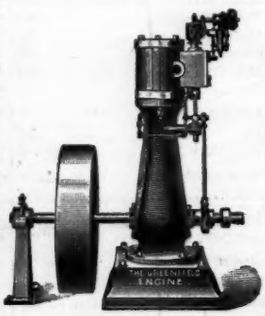

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ENGINES AND BOILERS.

Also Horizontal, Automatic and Variable Cut-off Engines.

Sizes from 3 to 75 Horse Power.

Also Vertical and Horizontal and Marine Boilers. Steam Pumps and Adams' Grate Bars.

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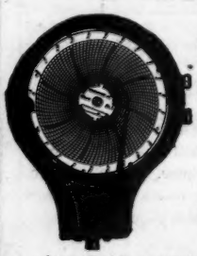

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Simple in Construction,
Accurate in Operation,
Low in Price,
Fully Guaranteed.

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Special Trays for Iron Sponge or Oxide of Iron.

CHURCH'S TRAYS a Specialty.

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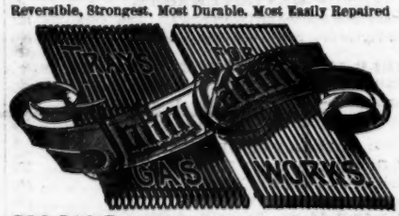

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We also make the Cheapest and Strongest REVERSIBLE BOLTED TRAYS IN THE MARKET

Send for Circulars.

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UNIFORMITY GUARANTEED.

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GAS ENGINEERING COMPANY,

INCORPORATED,

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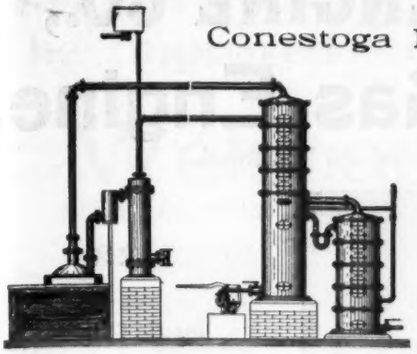

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MANUFACTURERS OF

Gas Works Machinery of all kinds,

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SOLE AGENT FOR

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For producing Sulphate, Aqua, Chloride and Concentrated Liquors.

The Erection of Bi-Product Coke Ovens a Specialty.

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NEW SYSTEM HYDRAULIC MAIN.

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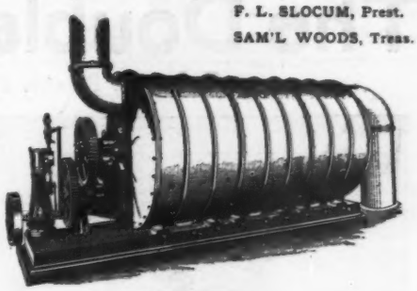

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CORRESPONDENCE SOLICITED.

Is Mined and Shipped from the Best Gas Coal Basin in Pennsylvania.

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If You Want the Best GAS-TIGHT Tubing,

BUY OF THE

NEW YORK GAS TUBING CO.

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GUARANTEED NOT TO STIFFEN. **Makers of All Kinds of Flexible Tubing.**

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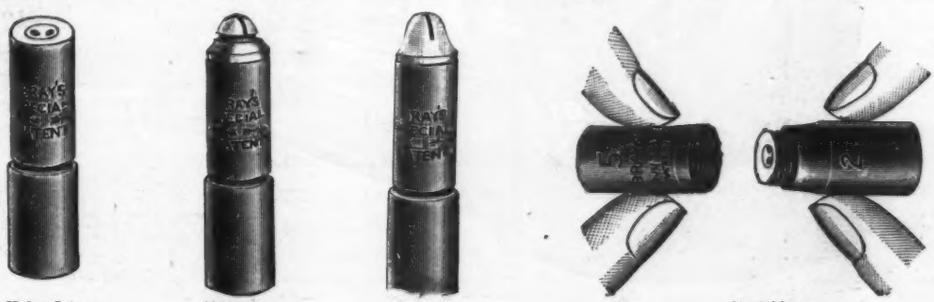
BRAY'S PATENT "ENAMELED" GAS BURNERS.

Bray's "Special" and "Adjustable" Burners

Are the Cheapest, Most Economical and Most Durable in existence, and will, at their REDUCED PRICE, save their cost in gas alone in forty hours' use.



Union Jet. Slit Union. Batswing. Adjustable.

Made with Inside Screw to Suit American Fittings.

The "Specials" are made to Suit Low and High Pressures. The "Adjustables" consist of two Burners screwed together, the size of which can be arranged to suit any Pressure and Consumption. For full description see Catalogue.

See that **"Bray's Special"** or **"Bray's Adjustable"** is stamped on each kind of Burner.

ACETYLENE AND RICH OIL GASES.—We now make Burners suitable for use with these Gases.

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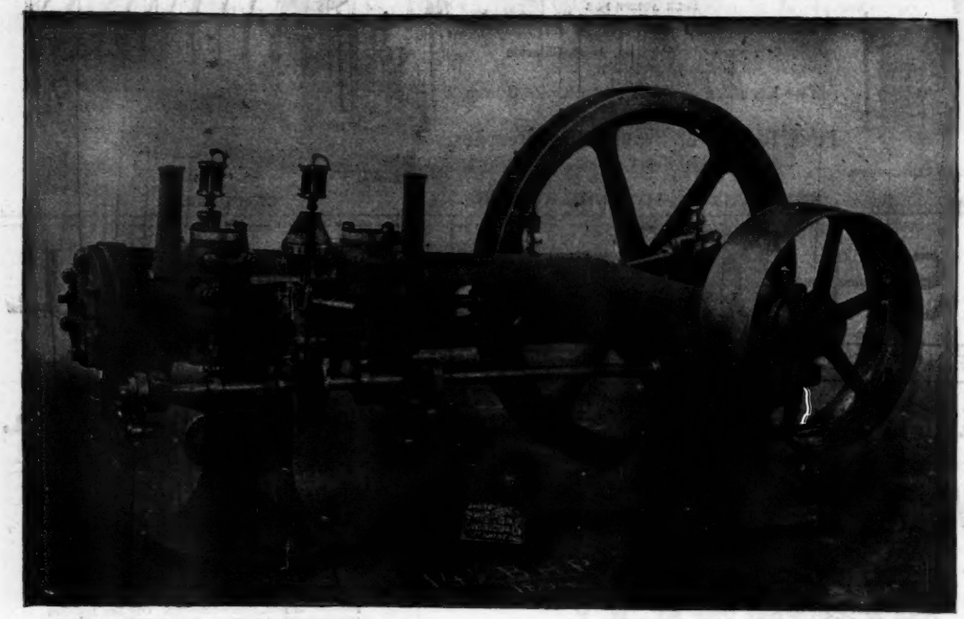
THE AMERICAN GAS ENGINE CO.,

MANUFACTURERS OF

The Double-Acting Gas Engine,

Under the Patents of Griffin, and Dick, Kerr & Co., of London and Kilmarnock.



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Single Cylinder.

Impulse Every Revolution.

(Two Strokes.)

15 to 500 Horse Power.

For General Work and Isolated Electric Plants.

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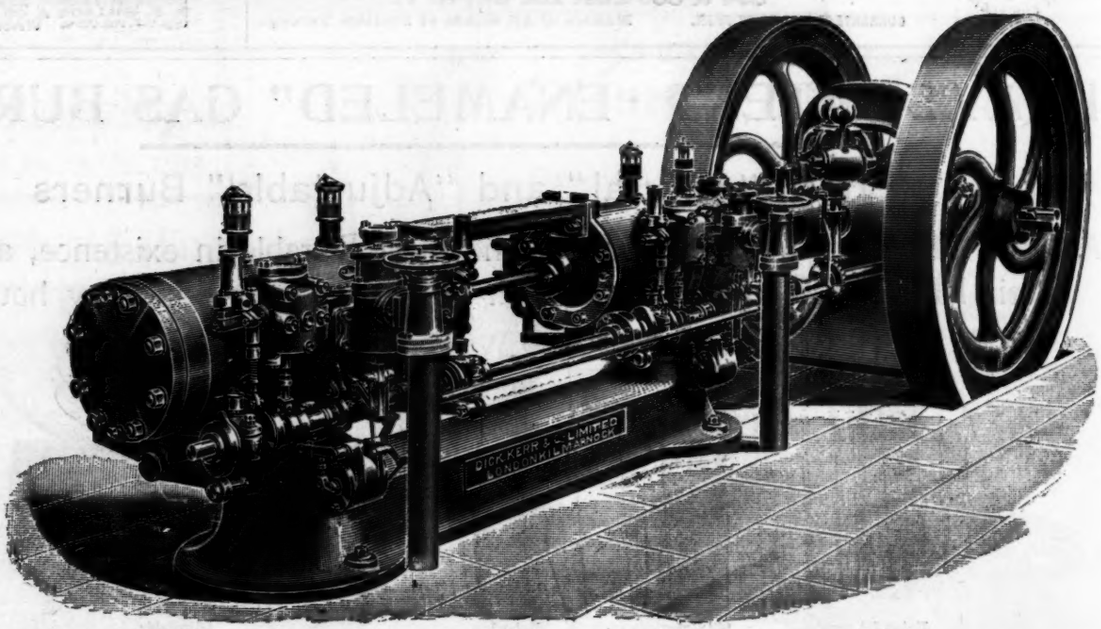
Tandem Cylinder.

Impulse Every Stroke.

100 to 1,000 Horse Power.

For Central Stations and all work requiring extreme steadiness.



ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

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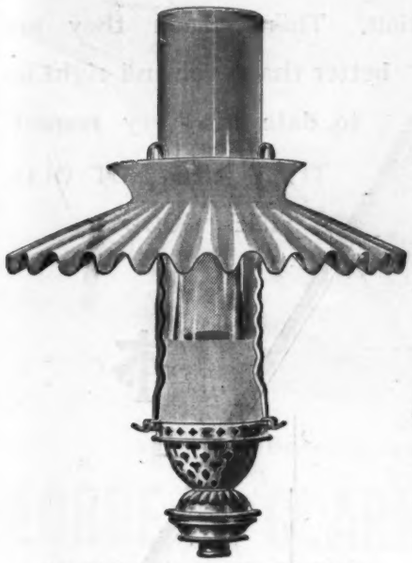
THE WESTERN GAS CONSTRUCTION CO. Bldrs. & Gen. Agts., Fort Wayne Ind.

The Improved

Welsbach Light.



No. 31 Burner, with No. 74 Shade.

No. 31 Burner, with Nos. 10 and 43 Shades.

Made by the

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Gloucester City, N. J.

Sole Manufacturers for the United States.

The WOLFF Gas Radiator.

Size, 33 Inches High, 21 Inches Wide and 10 Inches Deep. The Trilby Heaters are furnished in Brass, Copper-Bronze and Nickel Plate.

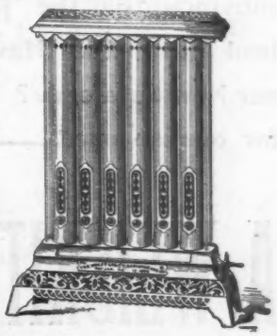
The Most Ornamental and Economical Gas Heater in the World.

The WOLFF Gas Radiators are no Longer an Experiment.

Heating with gas as a fuel instead of wood or coal was made practicable only four years ago, when the first WOLFF Gas Radiator was made. Since that time we have supplied Gas Radiators to heat all kinds of Rooms, Halls, Stores, Churches, Theaters, etc.; they are used in Bed Chambers, Sick Rooms, and wherever heat is required. And, because of their great success, several imitation Gas Radiators are offered, "said to be as good as Wolff's;" but none of them are as good. The WOLFF Radiator gives more and better quality of heat, at less cost, than any gas heater in the market.

In our Trilby Heater we again offer something **new, novel** and **good,** as well as beautiful and pleasing to the eye. Most Stoves, Heaters and Radiators in use heat the **top** of the room, leaving the **floor** cold (hence keep the head warm and the feet cold). Our Trilby Heater warms the floor first then the heat rises gradually, warming the whole room comfortably, cold air being drawn in from the bottom (passing between the heated radiating flues) and thoroughly warmed before passing out at the top, while the gas, mixed with air, is burned in our "Patent Incandescent Iron Fires Burners," which greatly intensifies the heat, causing an extra amount of heat to be radiated, or thrown off onto the floor, while the products of combustion are carried up through radiating iron flues to the top of the Trilby Heater, and downwards and out through opening to flue or chimney pipe connection, making a current or outlet for burnt gas or impure air, thus causing perfect ventilation in the room.

The Trilby uses less gas and gives more and better heat than any other Gas Radiator in the market.



MANUFACTURED BY

THE WOLFF GAS RADIATOR MANUFACTURING CO.,

Office, 164 Franklin St., New York.

FIRE KING GAS RADIATORS

These are the Handsomest, Best Finished and Most Powerful Gas Heaters in the World. They give the greatest amount of Heat for the quantity of Gas consumed, therefore being the most economical Gas Heaters to use.

These Gas Radiators are no experiment. They were brought out last Season and an immense number sold, and every one gave perfect satisfaction. This Season they are better than ever and right up to date in every respect. THEY ARE NOT OLD-TIME GOODS.

THE BEST IN THE WORLD.

Made with 4, 6, 8 and 12 Tubes, and finished in either Nickel or Bronze.

We also have something new in the way of a Square Gas Heater, which is the handsomest Stove of the kind on the market. Send us an order for Samples and be convinced that the "FIRE KINGS" lead all others. Have you got our New Catalogue? If not, write for one at once.

The Patent Lighter Cocks used on these Radiators, which have also been improved for this Season, are the finest Cocks ever put on a Gas Stove. We manufacture all these Cocks ourselves out of the best Brass and by skilled labor, and they are not like the common Cocks now used on Gas Stoves, and bought from the man who makes them the cheapest.

A. WEISKITTEL & SON, BALTIMORE, MD.

JEWEL GAS STOVES

This is One of Eight New Ranges.

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ARE MODERN

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UP TO DATE.

✻ Two New Laundry Stoves. ✻

✻ Six New Square Junior Stoves. ✻

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Fire Place Heaters,
Ranges, Broilers,
Laundry Stoves,

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Gas Kilns, etc., etc.
A New Line of
Radiators.

The "Eureka" Connection for Setting Meters.

Every Gas Company should consider this Device, as it is one of the utmost importance in the saving of Time and Material. Full description will be mailed on application.

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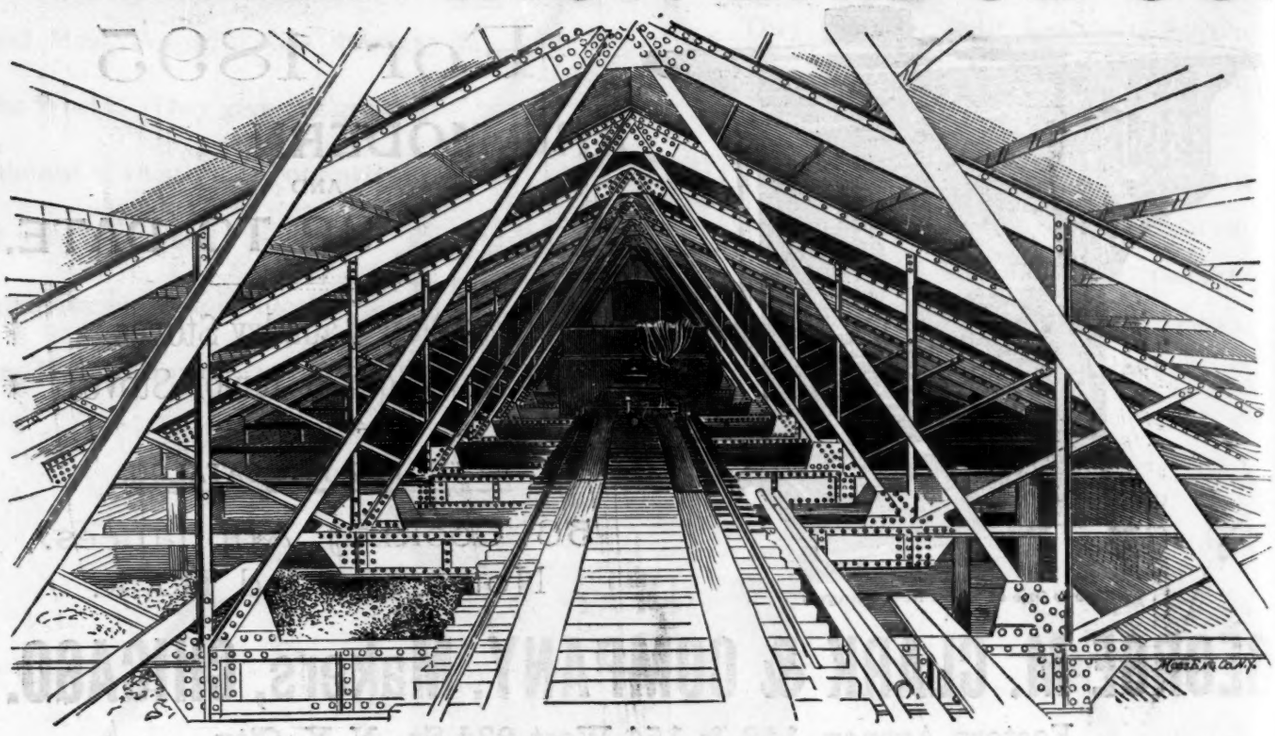

The above illustration is taken direct from a photograph, and shows an Iron Truss Roof designed and built by us for the Burlington City Water Works, at Burlington, Vt. The building is used for storing coal, and the roof is designed to carry a track through the trusses, so that the coal can be distributed from the car, and thus save handling. The roof is entirely of iron, no woodwork being used about it in any way, shape or manner, so that it is absolutely fireproof.

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ADVICE AS TO IMPROVEMENT OF GAS PROPERTIES AND MANAGEMENT.

THE MANAGEMENT OF SMALL GAS WORKS.

By C. J. R. HUMPHREYS.

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NEW YORK AND PHILADELPHIA,

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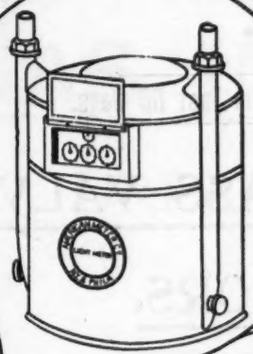
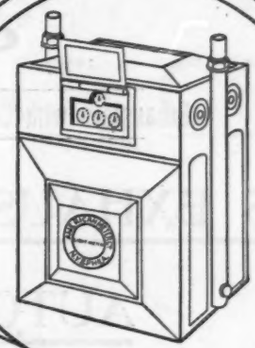
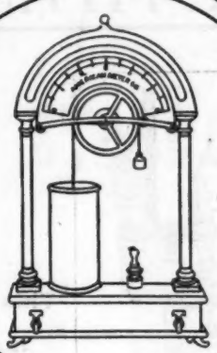
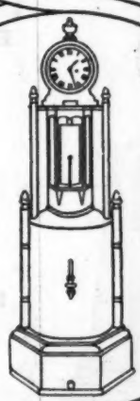
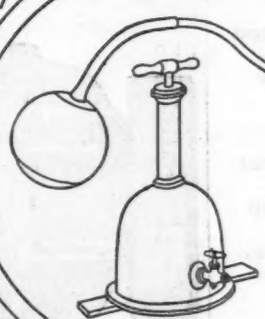
SAN FRANCISCO.

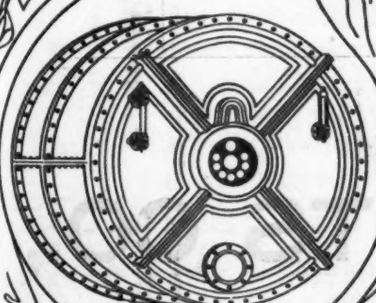


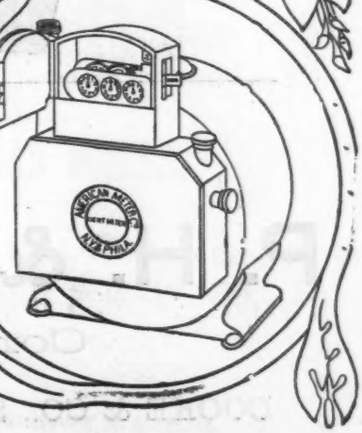












PUBLIC LIGHTING TABLE.

OCTOBER, 1895.

Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Tue.	1	3.40 AM	5.00 AM	5.30	5.00
Wed.	2	No L.	No L.	5.30	5.00
Thu.	3	No L. FM	No L.	5.30	5.00
Fri.	4	No L.	No L.	5.30	5.00
Sat.	5	6.00 PM	7.10 PM	5.30	5.00
Sun.	6	6.00	7.40	5.30	5.00
Mon.	7	6.00	8.10	5.30	5.00
Tue.	8	6.00	8.50	5.20	5.10
Wed.	9	6.00	9.50	5.20	5.10
Thu.	10	6.00	10.50	5.20	5.10
Fri.	11	6.00 LQ	12.00 AM	5.20	5.10
Sat.	12	6.00	1.20	5.20	5.10
Sun.	13	5.50	2.30	5.20	5.10
Mon.	14	5.50	5.10	5.20	5.10
Tue.	15	5.50	5.10	5.10	5.20
Wed.	16	5.50	5.10	5.10	5.20
Thu.	17	5.50 NM	5.10	5.10	5.20
Fri.	18	5.50	5.10	5.10	5.20
Sat.	19	5.50	5.10	5.10	5.20
Sun.	20	5.40	5.20	5.10	5.20
Mon.	21	5.40	5.20	5.10	5.20
Tue.	22	7.10	5.20	5.00	5.30
Wed.	23	8.20	5.20	5.00	5.30
Thu.	24	9.20	5.20	5.00	5.30
Fri.	25	10.20 FQ	5.20	5.00	5.30
Sat.	26	11.30	5.20	5.00	5.30
Sun.	27	12.30 AM	5.30	5.00	5.30
Mon.	28	1.30	5.30	5.00	5.30
Tue.	29	2.30	5.30	4.45	5.35
Wed.	30	3.30	5.30	4.45	5.35
Thu.	31	4.30	5.30	4.45	5.35

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146 30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45

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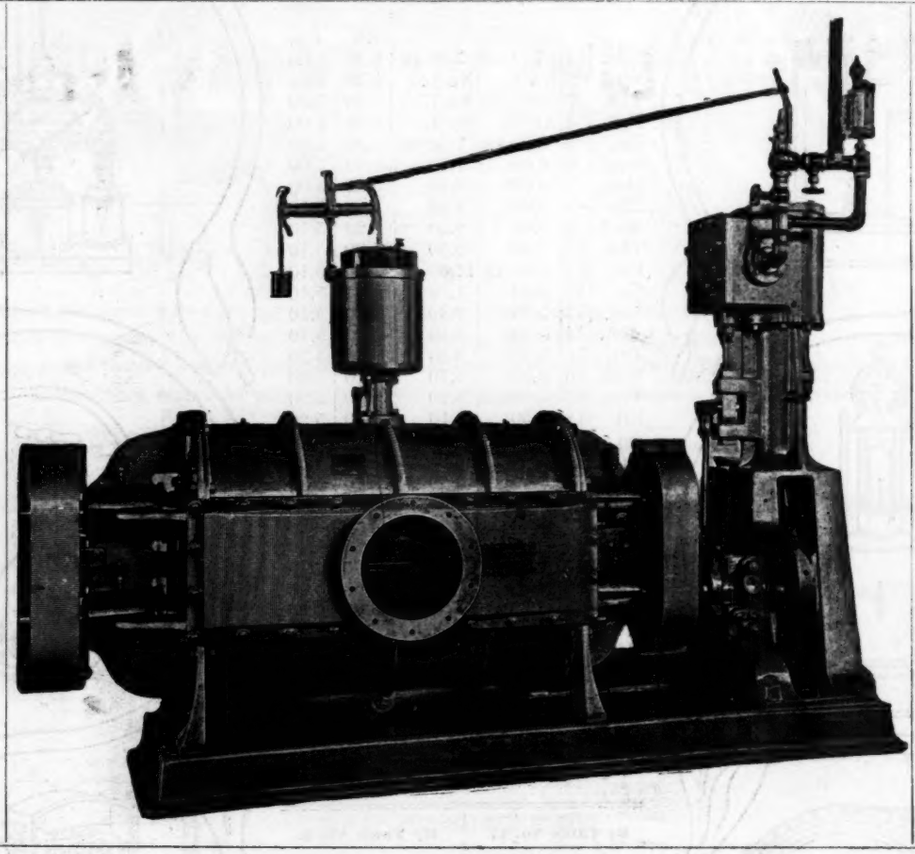

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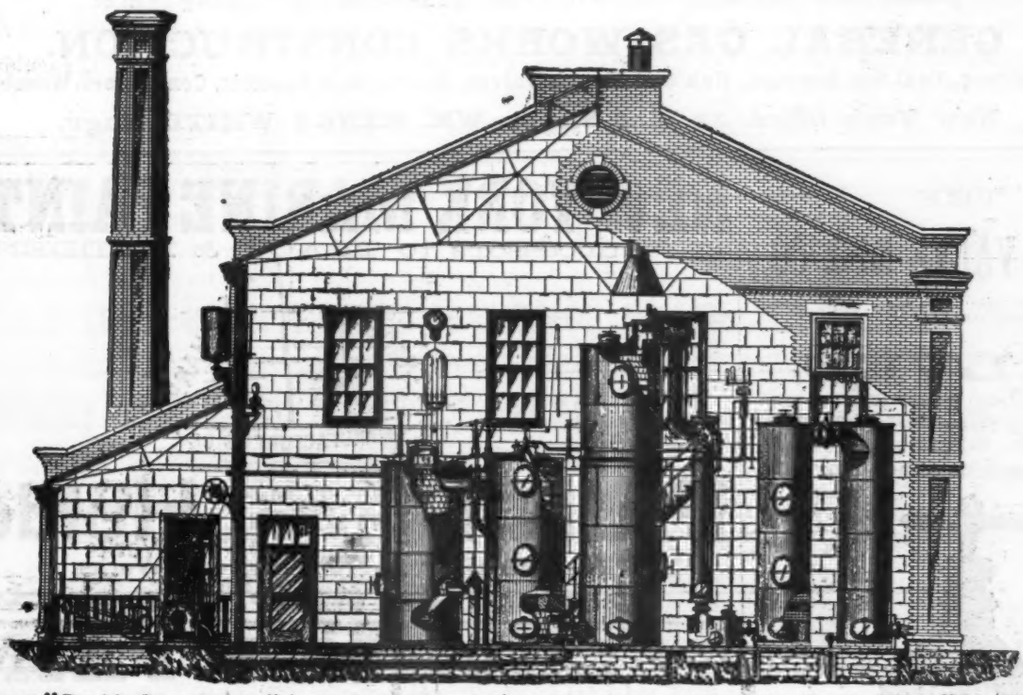

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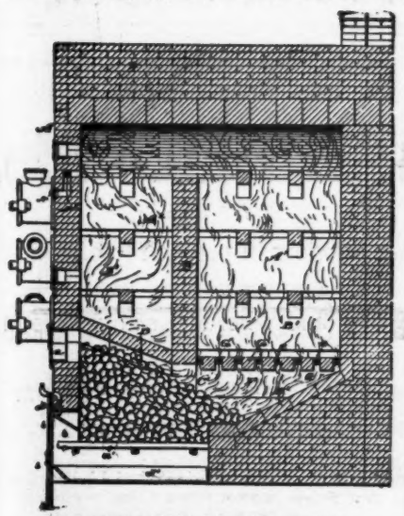

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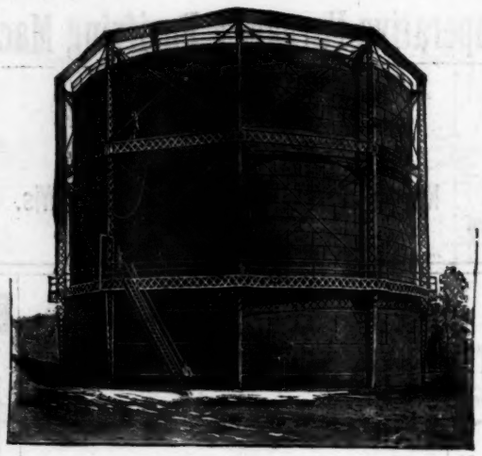

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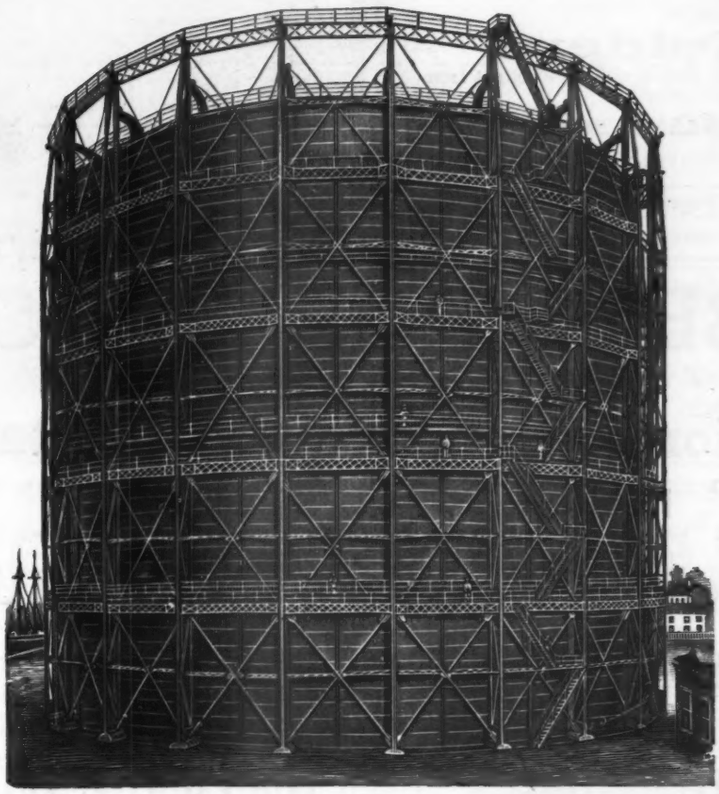

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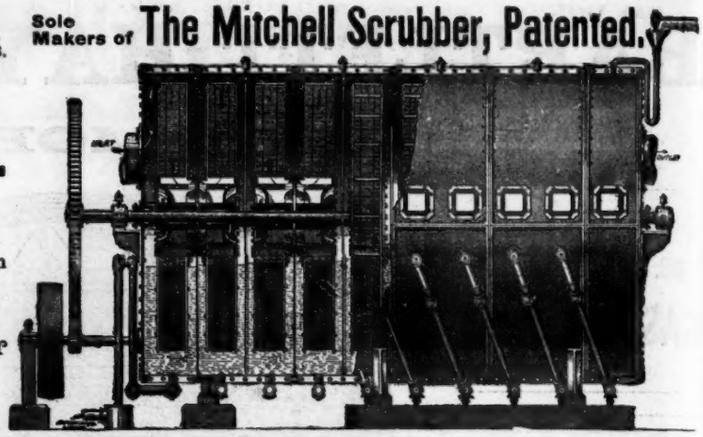

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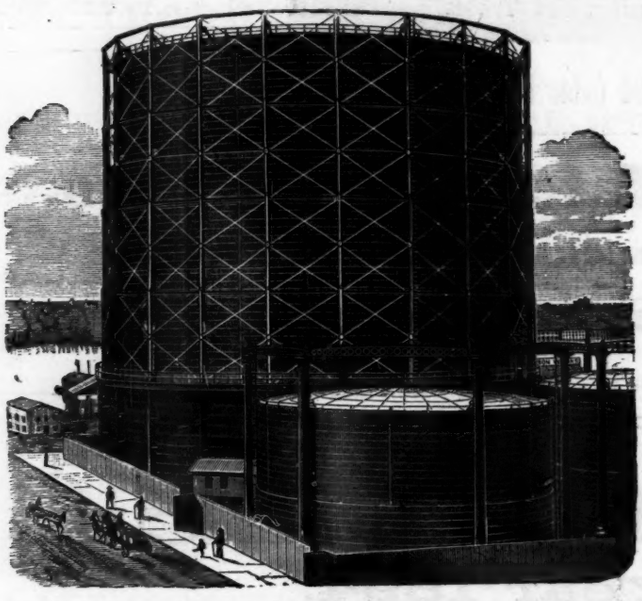

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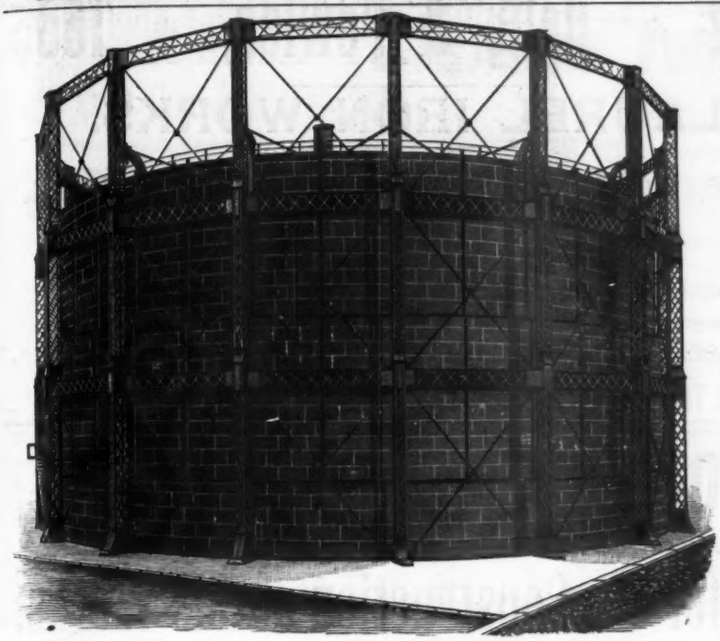

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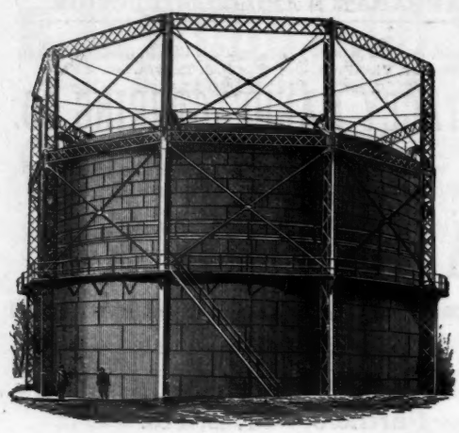

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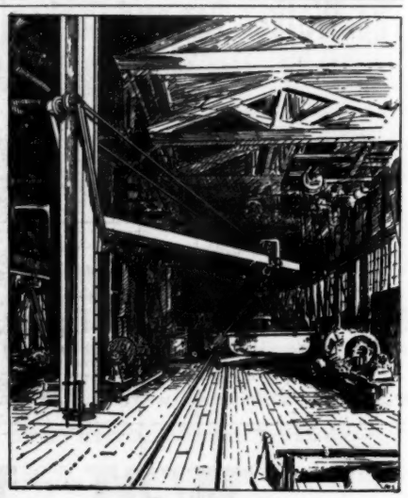

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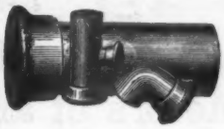

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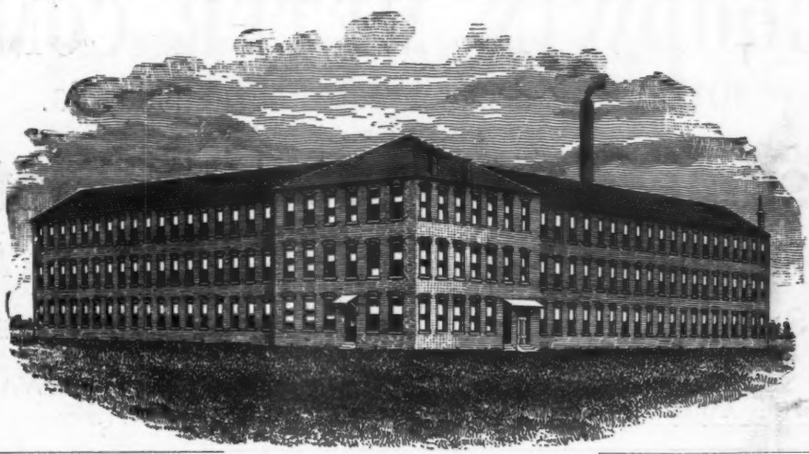

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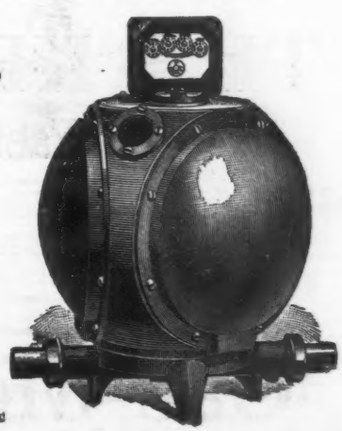

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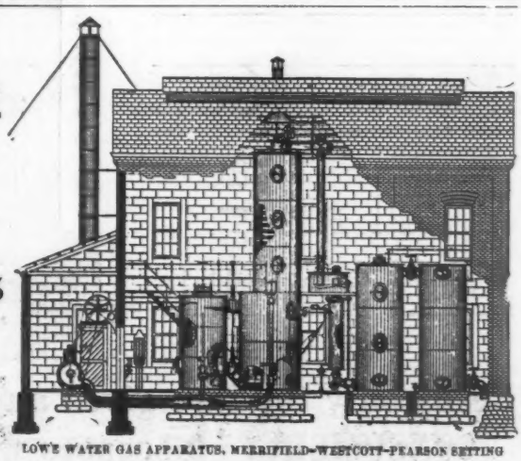

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